INTERNET UTILIZATION: A Case of Connected Rural and Urban Secondary Schools

By

George Kibet Kiptalam

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Declaration

This research project is my original work and has not been submitted for the award of degree in any other university.

Signed ..... Date 22.7.2009

George Kibet Kiptalam

P56/70610/2007

This research project has been submitted for examination with my approval as the University Supervisor.

Signed ..... Date 26th July 2009.

Prof. Anthony Rodrigues

Supervisor

Dedication

This research project is dedicated to my wife and son.

Acknowledgements

I am very grateful to my supervisor, Prof. Anthony Rodrigues for his effort and guidance to ascertain that this research project attained the required standards for examination.

I am also very grateful for the respondents who gave me permission to collect data for this research and spared the time to do so.

Abstract

The study looked at the utilization of the Internet among teachers and students in connected rural and urban secondary schools. The purpose of the study was to help policy makers, decision makers and investors make well informed decisions about public policy and investments in ICT especially at the secondary schools by understanding how the Internet and its related components are utilized in these schools. A survey design was used to guide the research process and participants drawn from 11 secondary schools. Survey questionnaires were distributed to 11 principals, 132 teachers and 752 students. The response rates were 100% for principals (n=11), 74.2% for the teachers (n=98) and 91.9% for the students (n=691).

Data generated was analyzed using the Statistical Package for Social Sciences (SPSS®). The main results has shown the extent to which the Internet is being utilized and has identified factors that enhance or impede Internet utilization at the secondary schools and which can be used to explain the integration of Internet into teaching and learning.

The findings of the study has shown that the use of Internet and its integration in the teaching and learning in secondary education is getting more widespread; and its use more pervasive among students and teachers as a means of communication and for information searching being common. Access rates for teachers and students have been observed to be much higher in educational institutions that have made effective ICT investments in education, translating into better utilization of ICT related technologies. The study also found that most of the schools which are connected are expending a substantial part of their annual budget on maintaining Internet connectivity, and this explains why it is estimated by the Ministry of Education that about 3% of the 6,566 secondary schools in Kenya have any form of Internet connectivity.

Strategies have been suggested on how to utilize the Internet to improve educational outcomes as recommendations given on issues that touch on ICT access and infrastructure; human resources and

training; policy environment; financing and ICT investment; curriculum development and locally relevant content.

Abbreviations

3G	3rd Generation
ADSL	Asymmetric Digital Subscriber Line
AISI	African Information Society Initiative
AKF	Aga Khan Foundation
CEPAK	Computers in Education Project in Kenya
CID	Centre for International Development (Harvard University)
DSL	Digital Subscriber Line
DVP	Digital Village Project
EDGE	Enhanced Data rates for GSM Evolution
EMIS	Education Management Information System
GPRS	General Packet Radio Service
ICT	Information, Communication and related Technologies
IDRC	International Development Research Centre
KIE	Kenya Institute of Education
NRI	Networked Readiness Index
UNCTAD	United Nations Conference on Trade and Development
UNECA	United Nations Economic Commission for Africa

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CHAPTER ONE

Introduction

1.1 Background to the Study

The use of Information and Communication Technologies (ICTs) has grown rapidly in Africa, particularly in the urban areas. The Internet has emerged as the most visible component of the dynamic developments of ICTs. As at March 2009, out of Africa's estimated population of 975 million, there were about 54 million Internet users in Africa, representing a 5.6 % penetration rate (Internet World Stats-Usage and Population Statistics, 2009). Kenya is ranked as seventh highest in Africa with the number of Internet users at 3 million, representing a 7.9 % penetration rate of the population. The low penetration rate is attributed to high bandwidth costs, lack of locally relevant content and limited ICT infrastructure in rural areas. Despite these limiting factors, the growth rate in penetration on the continent between 2000 and 2008 has been a phenomenal 1,100%. According to the *African Internet-A Status Report* published in July 2002, the use of Internet has grown much more rapidly in the urban areas as witnessed in the adoption of the mobile phone which followed after (Jensen, 2002).

The Government of Kenya through the Ministry of Information and Technology and Communication has recognized that ICTs can be a powerful tool for the achievement of economic and social development goals by improving communication and facilitating information. Unfortunately such developments have been more urban centred resulting in wide disparities between urban and rural areas in the distribution of ICT facilities. To address the existing disparities between urban and rural areas the Government announced the establishment of the Digital Village Projects (DVPs) on 8 June 2007 that is a collaborative approach, bringing together all partners from both the public and private sectors. Three types of ICT facilities under the DVPs have been envisaged: the digital schools that will see educational ICT facilities established in every administrative location with 5 PCs each; the digital kiosks that will be established in every constituency with 1 to 5 PCs each; and the digital

centres that will be established in every constituency with 10 to 20 PCs. Overall, it is expected that the project will support the establishment of at least 300 digital villages over a 3 year period with the expectations of increased Internet connectivity and access that will support e-health and e-learning among other initiatives to be rolled out (Ngahu & Nduati, 2007). The objective is to double the number of Internet users from the current 3 million to 6 million, and this will only be possible once the ongoing national and international marine projects of laying the fibre optic cables is complete in the second quarter of 2009 (Nyabiage, 2009). Already two such DVPs have been launched; one in Nyeri and the other in Butere districts, and it is expected that the digital villages will make tremendous contributions to learning and development of the areas (Butunyi, 2008).

The integration of ICTs into the educational curriculum has been promoted as a key step in bridging the "digital divide" and as a key component of the development of African economies. The Kenya Government developed *The National Information and Communication Technology (ICT) Strategy for Education and Training* in June 2006 which outlines how ICTs will be adopted and utilized to improve access, quality and equity in the delivery of education services in Kenya. Most developing countries are largely at the basic levels of integrating ICTs into their curriculum, placing emphases on new dimensions; pedagogical approaches; and teaching and learning that would enhance knowledge in interactive and self directed ways. This is commonly referred to as interactive education (Ministry of Education, Kenya, 2006). To this end, the National ICT Policy has been formulated to meet among other objectives, integrating of ICTs in teaching curriculum at all levels of education; establishing e-educational networks for sharing educational resources and promoting e-learning at all levels. A salient feature of the policy has been the promotion of computer science or information technology as a school-based subject in addition to the access, use, and integration of ICTs within the school systems.

1.2 General statement of the problem

There is lack of cross-country evidence on the utilization of Internet on the different sectors of the economy, and in some cases non-existent on account of recentness, the rapid revolution of ICTs and methodological challenges that include a deficiency of assessment variables and models of causality.

Attempts to measure or assess the utilization and impacts of ICT in Africa have been hampered by insufficient empirical data to indicate any impact of ICT on sector productivity. Most of the research (Kenya SchoolNet, 2003) and projects have tended to focus on information infrastructure issues, while few have been undertaken to measure the extent of Internet utilization as well as ICTs in Africa, particularly in education.

There is lack of consolidated documentation on what is actually happening in Africa as regards this area, or comprehensive baseline data on the state of ICT use in education in Africa against which future developments can be compared (Farrel, 2007).

According to the Kenya Government strategy paper, the implementation of the ICT strategy is an enormous endeavour on its part that calls for the need of systematic monitoring and evaluation (M&E) of all ICT related projects. It is hoped this will help us learn from past experience, improve service delivery, plan and allocate resources, and demonstrate results as part of accountability to key stakeholders.

Therefore, this research will attempt to describe the state of Internet utilization in connected rural and urban secondary schools of Kenya.

1.3 Problem statement

Developing countries, including Kenya are rapidly acquiring information technologies, and its uses are growing in many sectors. With the use of Internet increasing at a rapid rate, there is an expressed need among development agencies, policy makers, Internet providers and users to understand the utilization of Internet in the different sectors of the economy. Related to this is the need for

development of a practical framework to evaluate impacts of the Internet (National Research Council, 1998) that has been attributed to lack of consolidated documentation of what is actually happening in Africa on the state of ICT, and by extension Internet utilization in education in Africa against which future developments can be compared against.

There is very little literature on Internet utilization and factors that determine this utilization despite the increased adoption of ICTs in secondary schools. There is still lack of understanding on how these ICTs and their components are utilized and what factors determine their utilization.

1.4 Assumptions

The introduction of Internet to education in schools has been argued will bring about changes in the process of education and therefore enhance student learning. In order to determine these perceived changes and benefits, certain assumptions were made in regard to the study.

Amongst students, use of the Internet for searching of information will be least used by students at schools due to limited Internet connectivity and access to the computers and other ICT resources connected to the Internet, while word processing and use of CD-ROMs in schools will be the most used. The amount of experience a student has using computers and other ICT tools that are Internet based will therefore be quite limited.

Schools that provide Internet access to its students were assumed to be privately funded and making substantial investments in ICT related projects compared to the publicly funded schools, with the public schools relying on donations from individuals and institutions.

It was assumed that the type of Internet access that the schools have will be limited to individual telephone modems that are connected to single computers, more often in an office than a computer lab. Schools that had Internet access in the classrooms would also have at least some instructional rooms in their buildings with basic LAN-based internet connectivity.

Among the subjects taught, use of Internet will be predominantly used for computer science and information technology based subjects.

1.5 Purpose of the Study

The purpose of this research was to describe the factors associated with Internet utilization in connected rural and urban secondary schools.

1.6 Research objectives

1.6.1 To investigate the extent to which Internet is being utilized in secondary schools.

1.6.2 To determine the factors that enhances and impedes the utilization of Internet in secondary schools.

1.6.3 To develop a concept paper that will guide policy makers, decision makers and investors to make well informed decisions about public policy and investments in ICT.

1.7 Research questions

The research seeks to answer the following research questions;

1.7.1 What are the states of Internet connectivity and ICT tools in connected rural and urban secondary schools?

1.7.2 What are the ICT training opportunities for teaching and learning available for the teachers?

1.7.3 What are the Internet utilization profiles for connected rural and urban secondary schools?

1.7.4 What are the strategies that can be used to promote effective use of ICT related technologies in secondary schools?

1.8 Significance of the study

The study will add to the existing data and knowledge on the utilization of Internet in Kenya as regards the education sector at the secondary school level. The potential for the Internet to increase

economic growth and reduce poverty is receiving attention from Governments and the international community (UNCTAD, 2007).

Designing and implementing effective ICT policies and strategies therefore requires a proper knowledge of the state of ICT and its utilization by organizations and individuals, helping policy makers and decision makers to make well informed decisions about public policy and investments in ICT.

The study will hopefully lead to the development of effective measurement methodologies on the utilization of Internet, including basic ICT indicators that can be used in assessing the education sector in Kenya. Reliable and timely indicators on ICT are needed to maximize the potential of ICTs to facilitate a range of economic and social developments, including poverty reduction, increases in health and education standards, generation of new industries and employment opportunities, and improvements in competitiveness (World Summit on Information Society, 2005).

1.9 Limitations of the study

There were methodological and conceptual limitations faced in this study. Some of the methodological limitations experienced were those involving the sampling of the population, such as identifying which secondary schools had Internet connectivity in absence of accurate data from the relevant governmental departments and accessing these required data.

The conceptual challenges worth mentioning were getting the right operational definitions of the variables that have been used in the context of this study.

1.10 Operational definitions

1.10.1 Access

It has been defined as the ways and means in which individuals, communities and institutions have been exposed to ICTs. It has taken into consideration such elements as affordability, availability of the

technologies, geographical locations of access points, and the times at which the technologies are available.

1.10.2 Internet

The core definition deals with the interconnection of computer networks using a standard packet switching protocol for communications. Widely, it refers to the global network of computers which communicate over the Internet, providing access to a number of communication services including the World Wide Web and carrying email, news, entertainment and data files. However, we need to note that computers are used for many other purposes, not just for Internet applications; the telephone system over which Internet messages pass also has applications beyond the Internet (Daly, 2002).

In the African context, where institutions purchase computers and get connected to the telephone, and recently to mobile telephone to use the Internet, will prove difficult to distinguish the utilization of "the Internet" from the utilization of "the telephone" and those of "computer technology". Therefore within this realm of definition, this study has made an attempt to study the extent of utilization of the Internet regardless of the type of Internet connectivity available to schools.

1.10.3 Utilization

"Use" means the actual use of the Internet, while "Utilization" considers the actual use as compared to the available resources.

The utilization of the Internet depends on the capacity to use the available services. Such capacity may be measured in terms of the number of years in experience one has using computers, the number of computer applications one has mastery, as well as general levels of education and intelligence.

Direct measures of use of the Internet may include the number of hours per day that users spend at their terminals, number of emails they send and receive, and the web sites they visit.

1.11 Outline of the dissertation

The dissertation includes five chapters. The first chapter outlined background to the study, giving a general statement of the problem leading to the assumptions about the study. The purpose of the study has been stated, and the research objectives and questions formed that will guide the study. The operational definitions of the terms that are key to the study are given.

The second chapter has reviewed existing literature by other scholars and researchers on factors that influence adoption and use of Internet in education. The conceptual framework is also introduced and it is explained how this is linked to the development of the research tools used in the study.

The third chapter presents the research methodology that was used to carry out this study. The research design, research population, sample and sampling techniques, data collection and data analysis are explained.

The fourth chapter reviews the analyzed data that was collected from the research participants, and the observations made on the relationships between the variables.

The fifth chapter discusses the findings of the study in relation to the research objectives, conclusions and recommendations made by the researcher.

CHAPTER TWO

LITERATURE REVIEW

Introduction

This chapter reviews existing literature by other scholars on factors that influence the adoption and use of ICT related technologies in education, particularly the Internet. Although ICT in education is a relatively new area for research in Kenya, there are existing literature on some of the earliest studies undertaken, which for most part focussed on impact of ICTs in education and ICT infrastructural issues. Some of these studies sought to understand the factors that supported and impeded use of ICT and related technologies in the education sector, especially in secondary schools and highlighted some of the challenges that have been faced by the government and public sector in implementing ICT projects in the education sector.

2.1 Status of ICT usage in Kenya

Though the benefits of ICTs on education are still inconclusive as regards Africa, reported observations have included rapid expansion of knowledge, improved examination outcomes, enhanced communication, technical proficiency and greater decentralization of education services. It has also been argued that ICTs can also play a role in preparing students to competencies and skills that are fundamental in the emerging "knowledge economy". The use of ICT in education has the potential to enhance the quality of teaching and learning, the research productivity of the faculty and students, and the management and effectiveness of institutions (Kashorda, Waema, Omosa, & Kyalo, 2007).

But the opportunities for realizing the benefits of using ICT in education face a number of challenges in the developing countries. Access to ICT facilities is a major challenge facing most African countries, with a ratio of one computer to 150 students against the ratio of 1:15 students in the developed countries. In Kenya, the ratio for universities and colleges is 1:45 while access at the

primary school level is much more limited at 1:250 (Ministry of Education, Kenya, 2006). The Education Management Information System (EMIS) survey of 2003/2004 indicated that over 70 per cent of the secondary schools in Kenya required functional telephones. As of 2008, there were 6,566 secondary schools in Kenya, of which 4,261 were publicly funded and the rest 2,305 privately funded with a total student enrolment of 1,382,211 and total teaching staff of 43, 016 (Kenya National Bureau of Statistics , 2009). This in itself implies that about 4,600 of such schools could not access Internet services. Also indicated, was that 90 per cent of such schools needed to establish Local Area Networks (LANs) in order to improve sharing of learning resources.

The often uncoordinated training of teachers remains a barrier in the integration of ICT in education. Other existing barriers are gender disparities and the limited access to electricity that continue to frustrate the adoption of ICT particularly in the education sector (Ministry of Education, Science & Technology, 2005).

Worth mentioning are the following evaluations and studies that have been undertaken in the past to measure extent of usage of ICT; and the impact of ICT and related technologies in the education sector of Kenya.

2.1.1 Computers in Education Project in Kenya (CEPAK)

This was an evaluation of one of the earliest implementation of ICT projects in the education sector by the Aga Khan Foundation (AKF), which was responsible for introduction of computers in Kenya's secondary schools through CEPAK in 1983. The first phase began with the Aga Khan Academy which received five computers and the necessary software from AKF. After realizing the benefits of the project, AKF with funding from the International Development Research Centre (IDRC) and Rockefeller Foundation, set up a second phase introducing computers to four public secondary schools in Nairobi.

During the three year period of Phase II, the project was studied and evaluated by an independent research team (Makau, 1990). Three educational researchers carried out the study, using a variety of

research methods: examination of school records on the use of computers within the participating schools; observation of classes; and interviews with students, teachers and non-teaching staff. Two sets of written questionnaires were administered to teachers and students in 1986 (baseline year) and in 1988. In total, 170 teachers responded to these questionnaires in 1986 and 110 in 1988. For the students, 1,535 responded in 1986 while 2,671 responded in 1988. This represented a large-scale study on the use of computers in secondary schools in Kenya.

The CEPAK evaluation found that most computer-assisted lessons were observed to be in mathematics and the sciences. However, it was also found that in the majority of computer-assisted lessons teachers tended to be passive, thus leaving students to do whatever they chose. It found that some students regarded both formal and informal sessions on the computer as time for relaxation as opposed to serious learning (Makau, 1990).This approach to computer-assisted lessons was explained as being a result of the perception of the computer as an object of study; more exciting and potentially more rewarding than integration of the technology into the existing curriculum.

The research also found that computer studies lessons were conducted in the computer laboratory, thus they seemed to have priority over computer-assisted lessons in other subjects. It would appear that, both practically and symbolically, computer science was receiving more emphasis than integration of the technology into the rest of the curriculum. The evaluation also provided some very interesting findings with regard to gender issues in the use of computers. With regard to exposure outside the school (i.e. at home or elsewhere), female students were more disadvantaged than their male counterparts. The proportion of males that claimed to come from a home which owned a computer was nearly twice that of females, while 21% more boys than girls claimed to have used a computer outside school. Even more worrying, in mixed schools surveyed in the evaluation, female students claimed to have received less in-school exposure than the males.

2.1.2 SchoolNet Kenya

A research project conducted in November 2002 was based on the findings of a questionnaire to which 69 secondary schools responded, coming from all provinces and 46 districts in Kenya (Kenya SchoolNet, 2003). The research reported that only 46 per cent of the sampled schools had computers, with availability of Internet and facsimile rare in these schools. The findings also indicated that e-mail was yet to be recognised as a tool for collaboration among students and teachers, and only one school had a website while another two reported having networked all their computers to the Internet. It went on to affirm that in these schools, access to the Internet was severely limited and when available was only for administrative use.

The Kenya SchoolNet research found that almost 40% of schools had less than 10 computers, and therefore inadequate for teaching and learning. More than 20 per cent had less than 5 computers, indicating that the computers were mostly for administrative use. Only a third of schools surveyed had dedicated computer laboratories. The research also found that some schools were making use of very old equipment and there was dependency on donations of computers as opposed to sourcing locally.

Similar to findings of the evaluation of the CEPAK project, the Kenya SchoolNet survey revealed a significant difference in the quality and use of the computers in schools, depending on the gender of students there. Girls' schools were found to have the lowest numbers of computers, almost a third of that of boys' schools. Furthermore, the survey found that fewer of the computers were located in a computer laboratory in girls' schools, indicating their use predominantly in administration in girls' schools. The research concluded that fewer girls were being exposed to computers than boys.

Again, as in previous findings of the evaluation of CEPAK, the Kenya SchoolNet survey found a close association between mathematics and computer usage given that many computer teachers were themselves teachers of mathematics. This tendency created a perception that computer courses were closely linked to mathematics, and in turn explains why fewer girls than boys took computer lessons.

Consequently, the research concluded that girls would be marginal players in the emerging information society.

2.1.3 Investing in ICTs in educational institutions in developing countries

The most recent research on secondary schools was conducted by Pádraig Wims and Mark Lawler, both of Dublin University College in 2007. The findings are from two secondary schools – St. Patrick's High School and Singore Girls' Secondary School – and an agriculture training college, Baraka Agricultural College. The overall objective of the research was to evaluate the implementation of ICT projects in selected educational institutions with a view of making recommendations on how such projects can be deployed and supported.

In-depth semi-structured interviews were conducted with key members of management staff; 51 teachers from the schools and the college interviewed; 116 students responded to a questionnaire and 29 former students of the schools completed the questionnaires (Wims & Lawler, 2007).

The data collected to evaluate the teaching and learning programmes at these educational institutions were analyzed using the logic of Bennett's Hierarchy. The findings reported that half of Keiyo District's 32 secondary schools had at least some computer equipment installed, with over half of these schools offering computer lessons to their students. The average number of computers in the schools that offered computer lessons was 15, the highest recorded being 21, and the lowest at 10. The ratios of students to computers in the institution surveyed were: St. Patrick's, 25:1; Singore, 32:1 and Baraka, 4:1. In St. Patrick's, the computer laboratory had 16 working computers, with an average of 1.5 students per computer. Singore had a laboratory of 10 computers, and an average class size of 15, or a ratio of 1.5 students per computer. In Baraka Agricultural College, students had access to a computer laboratory of 12 computers. Only 12 students attended classes at any given time, allowing for a ratio of 1:1.

Of the institutions surveyed, it was only Baraka Agricultural College that was served by a fixed line. Though the institutions have email addresses, it seemed this was only available for administrative use.

And as regards website, it was St. Patrick's and Baraka that had websites, with the former appearing not to be updated regularly.

Funding for the deployment of the ICT infrastructure was locally for the secondary schools, with considerable donor support for the training college.

In regard to the students surveyed, it was found that half of the students surveyed in St. Patrick's had used a computer before joining the school, however the figure for the girls at Singore was much lower at 30 per cent.

2.1.4 *info*Dev / World Bank

The objective of the study was to bridge a crucial gap on knowledge of the use of ICTs in Africa. The report synthesized the findings from a survey of 53 African countries that was initiated by the Information for Development Programme (*info*Dev), a multi-donor partnership housed at World Bank which investigates issues related to the effective and appropriate use of ICTs in developing countries (Farrel, 2007). The survey was undertaken in response to needs expressed by international donor and development agencies, private sector organizations governments, and NGOs for a consolidated database of information focused on the following key questions:

- How are ICTs currently being used in the education sector in Africa, and what are the strategies and policies related to this use?
- What are the common challenges and constraints faced by African countries in this area?
- What is actually happening on the ground, and to what extent are donors involved?

The survey acknowledged that Kenya had made remarkable progress putting in place an ICT policy framework and implementation strategy, complete with measurable outcomes and time frames (Farrel, 2007). The findings generally indicated that most secondary schools had some computer equipment, which however could consist of one computer in the office of the school administrator. Although a small number of secondary schools had direct access to high speed connectivity though an ISP,

generally there was limited access to dedicated phone lines and high-speed connectivity for email and Internet. Roughly 10 per cent of secondary schools with computers were able to share teaching resources via a LAN.

However, the data presented in the individual country reports is to be regarded as illustrative rather than exhaustive.

Also worth mentioning is the SchoolNet South Africa survey of 2000-2001 that covered 10 schools (two from each of the five provinces) and with responses through questionnaires from 102 students and 17 educators. The specific objectives of the study was to include an attempt at investigating various start-up models for school networking in an African context, with respect to the following: establishing computer access and connectivity to the Internet; developing the capability of educators to utilise ICTs to enhance learning and teaching; developing local education content; and determining the extent to which national policy on the use of ICTs in education had been developed either under the influence of the SchoolNet or whether it had influenced the development of a SchoolNet. Paper-based questionnaires were used and interviews conducted, with an email survey of sent to all questionnaire respondents (Shakifa, Irene, & Thomas, 2002).

The study was commissioned by the International Development Research Centre (IDRC) Acacia Programme in partnership with the United Nations Economic Commission for Africa (UNECA) and SchoolNet Africa, as an important contribution to a larger study entitled Scan-ICT. The IDRC's Acacia Program is Canada's contribution to the African Information Society Initiative (AISI) which was developed in 1996 and which is spearheaded by the UNECA. SchoolNet Africa is one of the strategic pillars of the AISI's African Learning Network program.

Nevertheless, this research was focused on the SchoolNet initiative, with very little if any information gathered on the experiences at school level such as the extent to which investment in ICTs in schools affects the school's financial, social and educational environments and experiences.

In Kenya, the Ministry of Education's National Information and Communication (ICT) Strategy for Education and Training (Ministry of Education, Kenya, 2006) is cognizant that adoption of computers in the education sector 'has progressed, from acquisition of basic computer skills, computer aided teaching, communications and research, to usage in every subject', accelerated by the convergence of computer and telecommunications technology, particularly email and Internet. The strategy paper states that the impact of ICTs in education is still inconclusive in Kenya, but reported observations on indicators like examination outcomes have been positive.

All of the evaluations and research studies undertaken have used different methodological approaches to understand the extent of ICT utilization, and in turn inform on the benefits and impacts of ICTs in Kenya.

Of importance to note is the underlying common theme of understanding the dynamics of supply and demand to explain the benefits of ICTs in education, and often, overlooking the usage of such technologies that are likely to play a major role in determining the benefits and impacts being studies. Nor is there any conceptual or theoretical framework that has been suggested which would be used effectively in undertaking a successful study on the utilization of ICTs, and therefore the Internet. Nor is there any methodological approach suggested that would be considered effective in undertaking such a study in a country like ours that faces challenges in implementing ICTs in education.

From the literature reviewed, it has been noted that there is very limited information available on the experiences of African learners, teachers and school managers on the use of ICTs. Very limited information is available too, on the supply chain of the ICTs in schools – the nature and extent of government ministry involvement, the involvement of the parent and residential communities in which the schools are located and the role of the private sector. This study will hopefully open the way for further investigation into these areas.

2.2 Conceptual framework

The conceptual framework for the study was adapted from the National Research Council (National Research Council, 1998) and has been based on the utilization of the Internet rather than penetration of the Internet and the impacts that result. This adapted framework used modified indicators and sub-indicators that have been derived from an e-readiness assessment tool originally developed by the Centre for International Development (CID) at Harvard University, and which was modified for use in assessing the e-readiness of higher education institutions in Kenya (Kashorda, Waema, Omosa, & Kyalo, 2007). The tool organizes the assessment of numerous factors that determine the Networked Readiness of a community in the developing world. It makes use of the Networked Readiness Index (NRI) that measures not only the regulatory and national infrastructure but also usage by government, businesses individuals.

For this study the indicators and sub-indicators were modified so as to be organized around four domains. The resulting framework is in a matrix format and in the form of Internet supply and demand, in which impacts of the Internet can best be understood by measuring the extent of Internet usage. Indicators are then offered as tools to help measure the direct and indirect usage of Internet. In very simple terms, the relationship between supply and demand factors can be shown as:

Environment ↔ Internet ↔ Organizations ↔ Sector Impacts

In this simple relationship, the environment influences the supply and demand for Internet services; those services are used by individuals and organizations, and it this utilization that the study seeks to measure and understand; which in turn affect sector development.

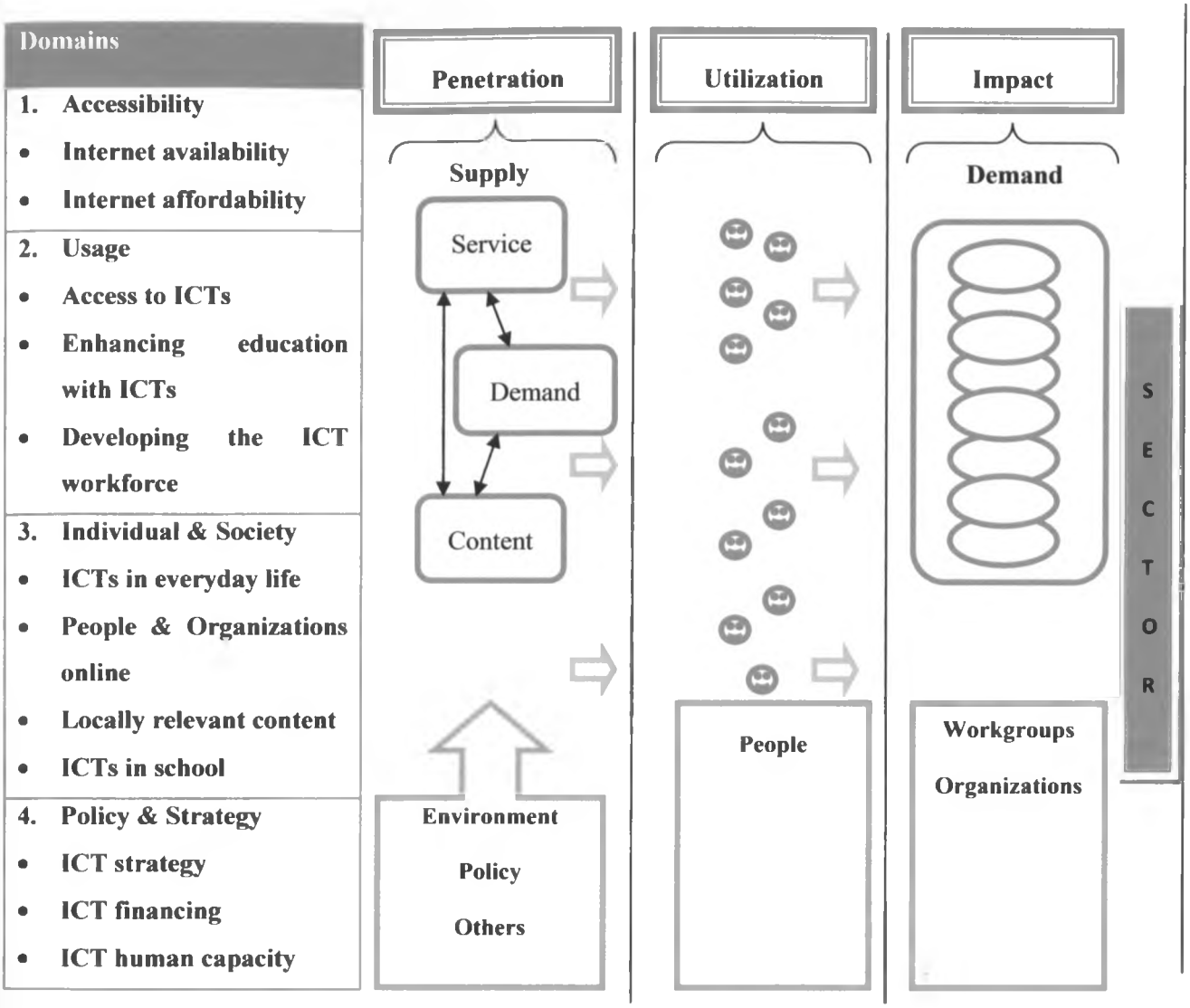

Figure 1. Illustration of the conceptual framework

The resulting set consisted of 12 relevant indicators that were grouped into four domains as follows;

2.2.1 Accessibility

Attempts to answer the question-What is the availability, cost and quality of ICT networks in secondary schools?

The Internet availability indicator will be measured by looking at the networked PCs per 100 students, while that of Internet affordability tries to determine whether secondary schools find

Internet costs costly. Affordability will be defined by comparing the costs of Internet bandwidth as a percentage to the total expenditure of the school.

2.2.2 Usage

Attempts to answer the question-Does the educational system integrate ICTs into its processes to improve teaching and learning?

Access to ICTs will have 6 sub-indicators- number of computers, physical access to the technology, types of computers, diffusion of the network, access to and organization of electronic content, and quality and speed of connectivity in the school.

Enhancing education with ICT will have 4 sub-indicators-educational software usages; use of course management systems; use of ICT in curricula and use of ICT in student projects.

Developing the ICT workforce will have 2 sub-indicators-numbers of teachers with professional certification and availability of training opportunities for teachers and staff.

2.2.3 Individual and Society

It attempts to answer the question-To what extent are individuals using information and communication technologies at work and in their personal lives? Are there significant opportunities available for those with ICT skills?

The ICTs in everyday life indicator will have 5 sub-indicators- percentage of respondents with school access to computers; percentage of respondents whose main access to Internet is cyber cafe; number of respondents with home access to Internet; percentage of respondents using computers for email/Internet; and percentage of respondents using computers for word processing.

The people and organizations online indicator will have 5 sub-indicators-percentage of respondents who have never used the Internet; percentage of respondents who consider

Internet most important for email; percentage of respondents who consider Internet most important for academic work; percentage of respondents who use Internet daily; and percentage of respondents with email accounts.

The locally relevant content indicator will have 2 sub-indicators- percentage of respondents visiting local websites; and number of respondents visiting web portals with Kenyan information.

The ICTs in the schools indicators will have 3 sub-indicators- percentage of teachers using Internet for academic work; percentage of teachers with access to Internet from the office; and percentage of teachers staying online.

2.2.4 Policy and Strategy

The ICT strategy indicator will look at the strategic planning for ICT and organizational structure of ICT in the schools.

The ICT financing indicator is composed of 2 sub-indicators- percentage of Internet costs to the total school expenditure; and percentage of the ICT budget to the total school budget.

The ICT human capacity indicator will be defined by a sub-indicator in terms of percentage of staff who has worked over 5 years

One would therefore seek to understand the overall usage of Internet in terms of the aggregate usage of the Internet on these subsystems, on the linkages among them, and on the way in which the educational system evolves in the Internet era. One would also seek to understand the factors that are responsible for non-use of the Internet as well as use of the Internet.

CHAPTER THREE

RESEARCH METHODOLOGY

Introduction

This chapter presents the research methodology that was used to carry out this study. The research design, research population, sample and sampling technique, data collection and data analysis are explained.

3.1 Research setting

The study was conducted in rural and urban secondary schools from Nairobi and Rift Valley provinces. The secondary schools surveyed were selected on the most important criterion: that the schools had some form of Internet access. Due to constraints in time and resources, eleven secondary schools were surveyed for convenience.

3.2 Research design

The study was a cross sectional descriptive survey using quantitative approaches to data collection, analyses and reporting.

3.3 Research population

The study focussed on teachers and students in secondary schools. The students were drawn from all the classes.

3.4 Sampling and sampling procedure

The respondents were selected as follows;

- Using the linear simple sampling approach required the class register as sampling frame which was available in these schools.

Since there were no estimates available of the target population using the Internet in these schools, 50 per cent was used as recommended by Fisher (Fisher, Laing, Stoeckel, & Townsend, 1999). The following equation was used to obtain the estimate (see equation 1 and 2).

$$n = Z^2pq/d^2 \quad \text{....eq. 1}$$

Where:

n=the desired sample size (when population is greater than 10,000)

z=the standard normal deviate at the required confidence level, set at 1.96

p=the proportion in the target population estimated to have characteristics being measured. Since there is not available estimate, we will use 50 per cent (0.5)

q=1-p

d=the level of statistical set

$$n = 1.96^2(.5)(.5)/(.05)^2 \quad \text{....eq. 2}$$

n=384

But since the entire population (N) is less than 10,000, the required sample size will be smaller. We got the final sample estimate (n_f) by using the following equation (see equation 3):

$$n = \frac{n}{1} + \frac{n}{N} \quad \text{....eq. 3}$$

Where:

n_f= the desired sample size (when population is *less than* 10,000)

n = the desired sample size (when the population is *more than* 10,000)

N = the estimate of the population size

$$n_f = \frac{384}{1 + \frac{384}{1920}} = 385$$

However a final sample of 691 (10.3%) students was randomly selected from the eleven schools with a student population of 6,681 to take into account the different categories of schools and Internet accessibility. Also selected for random sampling were 98 (20.9%) teachers respondents from of a total population of 468 teachers and all 11 (100%) principals of the 11 schools sampled.

3.5 Data collection and analysis

Data was collected from the principals, teachers and students using an interviewer-administered standardized questionnaire measuring ICT indicators for each of the target populations in the secondary schools over a period of 6 weeks. The questionnaire used the twelve indicators grouped into the four domains in the conceptual framework developed-accessibility; utilization; individuals and society; and policy and strategy. The questionnaire was directed to the respondents by the researcher over a four-week period.

Information on the characteristics of the populations was collected. Other information collected included accessibility to ICT facilities, pattern of ICT and related facilities, level of skills in computer applications, and purposes and extent of use of the Internet.

The Statistical Package for Social Sciences (SPSS®), Stata® and Crystal Reports® 11were used for analysis of the data collected, with various statistical analysis for descriptive data such as chi-square, weighted means, Pearson's contingency coefficient and variance test measures carried out.

CHAPTER FOUR

RESEARCH FINDINGS

Introduction

This study used directed questionnaires which were completed by the institutional heads of the secondary schools, the teachers and their students. The questionnaires administered to the 11 schools took a period of 6 weeks to obtain the data. The sample sizes for the questionnaires took into account the student population, different categories of students and their teachers. The students sampled were from the 7 classes as indicated in the questionnaires (see Table 1). Of the schools sampled, 2 were girls' only schools; 6 boys' only schools and the remaining 3 schools mixed. Girls were the majority of the students sampled at 67.9%, and students from rural based schools were 280 (40.5%) compared to 411(59.5%) students from urban based schools.

Table 1. Sample size of the students' different classes

Gender	Area setting	Year of Study							Sub Total
		Form 1	Form 2	Form 3	Form 4	Form 5	Form 6	Pre Form 1	
Male	**Rural**	17 (7.7%)	22 (9.9%)	19 (8.6%)	22 (9.9%)	0	0	0	80 (36%)
	Urban	27 (12.2%)	25 (11.3%)	30 (13.5%)	2 (9.9%)	17 (7.7%)	12 (5.4%)	9 (4.1%)	142 (64%)
	Sub Total	**44 (19.9%)**	**47 (21.2%)**	**49 (22.1%)**	**44 (19.8%)**	**17 (7.7%)**	**12 (5.4%)**	**9 (4.1%)**	**222 (100%)**
Female	**Rural**	45 (9.6%)	52 (11.1%)	49 (10.4%)	54 (11.5%)	0	0	0	200 (42.6%)
	Urban	75 (16%)	68 (14.5)	54 (11.5%)	45 (9.6%)	14 (3%)	6 (1.3%)	7 (1.5%)	269 (57.4%)
	Sub Total	**120 (25.6%)**	**120 (25.6%)**	**103 (21.9%)**	**99 (21.1%)**	**14 (3%)**	**6 (1.3%)**	**7 (1.5%)**	**469 (100%)**
Total		**164 (23.7%)**	**167 (24.2%)**	**152 (22%)**	**143 (20.1%)**	**31 (4.5%)**	**18 (2.6%)**	**16 (2.3%)**	**691 (100%)**

Table 2 shows the different categories of the respondents. A total of 780 valid questionnaires were coded and entered into a database and used for analysis. About 89% of the respondents were students.

Table 2. Categories of respondents

School type		District	School	Teachers		Students	
Category	**Area**			**Frequency**	**%**	**Frequency**	**%**
Private	Rural	Ngong	Brother Beusang Catholic Secondary School	8	8.2	30	4.3
	Urban	Nairobi	Aga Khan Academy	11	11.2	90	13.0
		Nakuru	Greensteds International School	6	6.1	37	5.4
Public	Rural	Baringo	Kabarnet High School	4	4.1	49	7.1
		Naivasha	Naivasha Girls Secondary School	7	7.2	64	9.3
			Utumishi Academy	10	10.2	66	9.5
		Koibatek	Emining Secondary School	12	12.2	71	10.3
	Urban	Nairobi	Nairobi School	10	10.2	73	10.6
			Starehe Boys Centre & School	7	7.2	70	10.1
		Nakuru	Nakuru Boys' High School	12	12.2	70	10.1
			Nakuru Girls' High School	11	11.2	71	10.3
Sub-total				**98 (12.4%)**	**100**	**691 (88.6%)**	**100**

4.1 School principals

From Table 3 there is a significant difference between private and public schools. Both ratios – of teachers to students and computers to students – are much lower in private schools than those public schools. This is attributable to the low enrolment at private schools than those witnessed in the public schools. There does not seem to be any significant difference between rural and urban based schools, and neither does it appear to be any bias in terms of gender when considering schools' enrolment.

Table 3. Population of teachers and students in the sampled schools

School type		School	Teachers	Students		Total Students	Teacher to Student ratio	Computers	Computer to Student ratio
Category	Area			Female	Male				
Private	Rural	A	37	211	170	381	1:10	60	1:6
	Urban	B	40	225	172	397	1:10	80	1:5
		C	42	120	150	270	1:6	50	1:5
Public	Rural	D	54	0	580	580	1:11	55	1:11
		E	28	467	0	467	1:17	20	1:23
		F	41	832	0	832	1:20	50	1:17
		G	24	0	600	600	1:25	20	1:30
	Urban	H	60	0	1,170	1,170	1:20	60	1:20
		I	31	0	889	889	1:29	30	1:30
		J	63	0	900	900	1:14	50	1:18
		K	48	735	0	735	1:15	36	1:20
Total			**468**	**2590**	**4,631**	**7,221**			

The private schools charged annual tuition fee ranging from Ksh. 300,000 (USD 3,750) to Ksh. 1,150,000 (USD 14,375). One of the schools, charging Ksh. 20,000 (USD 250) had heavily subsidised the tuition fee payable by up to 80% so as to cater for the surrounding community from its endowment funds. The public schools charged annual tuition fees that ranged from Ksh 36,000 (USD 450) to Ksh 120,000 (USD 1,500). For this study the schools were classified as Low, Medium or High cost based on the annual tuition fees charged as shown in Table 4.

Table 4. Classification of schools based on annual school fees charged

Classification of schools	Annual school fees range
Low cost	Less than Ksh. 50,000 (< USD 625)
Medium cost	Ksh. 50,000-150,000 (USD 625-1,875)
High cost	More than Ksh. 150,000 (USD 1,875 +)

Table 5 indicates that 7 (63.7%) of the schools can be therefore be described as low cost, with 5 (45.5%) being rural based and 2 (18.2%) urban based. One of these low cost schools is a private and rural based school that charges Ksh. 20,000 with heavy subsidies from its endowment fund. The low

cost schools appear to have low ratios of both teacher to students and computer to students. Other 2 (18.2%) schools are classified as medium cost and are all public, with ratios much higher than the low cost schools and which is attributed to the high enrolment. The remaining 2 (18.2%) schools that are private and urban based were classified as high cost, with very low ratios of teacher to students and computer to students as compared to the low and medium cost schools.

Table 5. Teacher and computer ratios among schools classified on the basis of school fees charged

	Area setting	Frequency	Teacher to Students ratio	Computer to Students ratio
Low cost	Rural	5 (45.5%)	1:17	1:17
	Urban	2 (18.2%)	1:15	1:19
Medium Cost	Rural	0 (0%)	n/a	n/a
	Urban	2 (18.2%)	1:25	1:25
High Cost	Rural	0 (0%)	n/a	n/a
	Urban	2 (18.2%)	1:8	1:5

4.1.1 Accessibility Indicators

4.1.1.1 Internet availability

From Table 6 the most common type of Internet connection arrangements in the schools with their Internet Service Provider (ISP) was through DSL/ADSL with Telkom Kenya's Kenstream link that had data rate speeds of between 128 and 256 kbps with 5 (45.5%) schools. Other types of Internet connectivity arrangements in the schools that were sampled were: 2 (18.2%) schools on leased lines with data rate speeds of 256-384 kbps; 2 (18.2%) schools on Wi-Fi with data rate speeds of 256 kbps; 1 (9.1%) school on mobile cellular broadband modem with data rate speeds of 56-114 kbps on GPRS, up to 236 kbps on EDGE and 5.8 mbps on 3G; and 1 (9.1%) school on dial up access with data rate speeds of 115 kbps. This summary of data is illustrated in Figure 2.

Table 6. Overall types of Internet connection arrangements in schools

Types of Internet connection arrangements	Frequency	Percent
Dial up	1	9.1%
Leased line	2	18.2%
ISDN/DSL	5	45.5%
Wireless	2	18.2%
Mobile Broadband Cellular modem - GPRS/EDGE/3G	1	9.1%
Total	**11**	**100%**

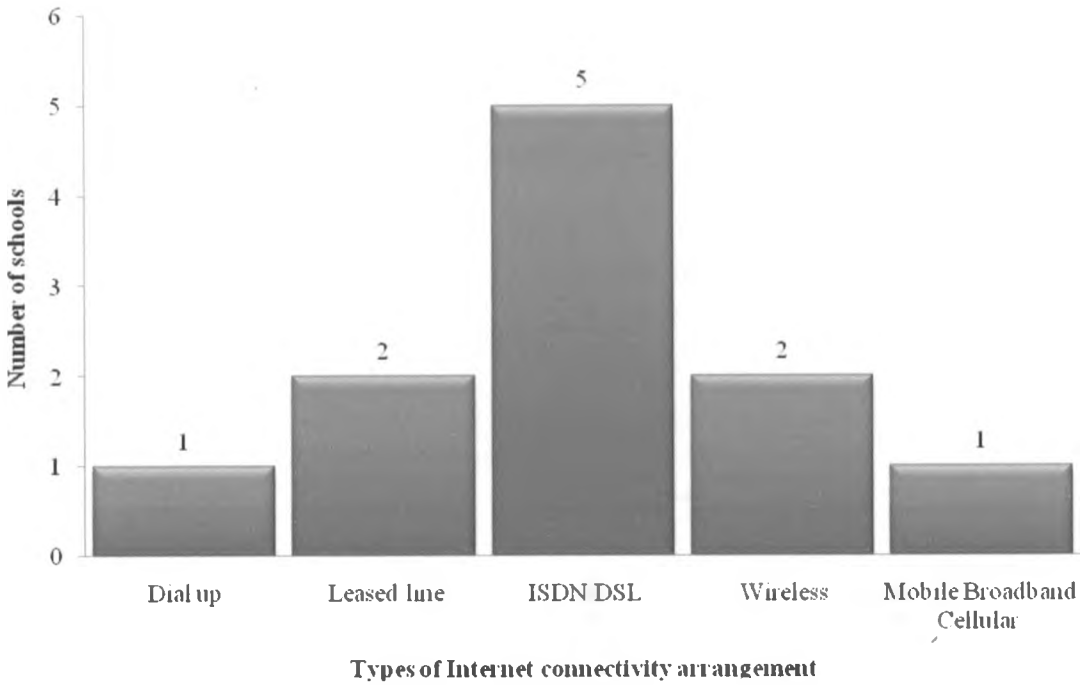

Figure 2. Types of Internet connection arrangements

When attempting to analyze the different types of Internet connectivity arrangements as regards the schools' area settings, there was no linear relationships using the Pearson's correlation coefficient measure between the areas where the schools were located or type of funding (whether privately or

Table 7 (a). Types of Internet connection arrangements in the schools by school category

Category	Types of Internet arrangements	Area		Sub-Total
		Rural	Urban	
Private	Leased line	0 (0%)	1 (9.1%)	1 (9.1%)
	Wireless	0 (0%)	1 (9.1%)	1 (9.1%)
	Mobile Broadband Cellular modem - GPRS/EDGE/3G	1 (9.1%)	0 (0%)	1 (9.1%)
	Sub-Total	***1 (9.1%)***	***2 (18.2%)***	***3 (27.3%)***
Public	Dial up	1 (9.1%)	0 (0%)	1 (9.1%)
	Leased line	0 (0%)	1 (9.1%)	1 (9.1%)
	ISDN/DSL	3 (27.3%)	2 (18.2%)	5 (45.5%)
	Wireless	0 (0%)	1 (9.1%)	1 (9.1%)
	Sub-Total	***4 (36.4%)***	***4 (36.4%)***	***8 (72.8%)***
Total		**5 (45.5%)**	**6 (54.5%)**	**11 (100%)**

Table 7 (b). Pearson correlation coefficient tests (2-tailed)

		Area settings	Internet connection arrangement type
Area settings	Pearson Correlation	1	.080
	Sig. (2-tailed)	.	.814
	N	11	11
Internet connection arrangement type	Pearson Correlation	.080	1
	Sig. (2-tailed)	.814	.
	N	11	11

		School funding	Internet connection arrangement type
School funding	Pearson Correlation	1	-.374
	Sig. (2-tailed)	.	.257
	N	11	11
Internet connection arrangement type	Pearson Correlation	-.374	1
	Sig. (2-tailed)	.257	.
	N	11	11

Table 8 shows the cross tabulated responses of the schools as regards access to the Internet in terms of hours in a month. Majority of the schools, about 82% had more than 40 hours in a month of Internet access, while two schools (18%) had less than 20 hours in a month of Internet access which had computer laboratories with non-networked computers, hence the reason for the low access times.

Table 8. Schools' monthly access to the Internet

Area	Funding type	Hours in a month		Total
		5-20 hrs	More than 40 hrs	
Rural	Private	0 (0%)	1 (9.1%)	1 (9.1%)
	Public	1 (9.1%)	3 (27.3%)	4 36.4%)
Sub-Total		***1 (9.1%)***	***4 (36.4%)***	***5(45.5%)***
Urban	Private	0 (0%)	2 (18.2%)	2 (18.2%)
	Public	1 (9.1%)	3 (27.3%)	4 (36.4%)
Sub-Total		***1 (9.1%)***	***5 (45.5%)***	***6 (54.6%)***
Total		**2 (18.2%)**	**9 (81.8%)**	**11 (100%)**

4.1.1.2 Internet affordability

When the total costs spent on maintaining Internet access as a proportion of the schools' total expenditures expressed as a percentage was considered, all private schools indicated that this made up less than 5% of their annual expenditure.

Table 9 illustrates this contrast with the public schools, where only 2 (18.2%) of the 8 sampled schools reported a cost expenditure on Internet access of less than 5%, each from the urban and rural settings. Of the remaining 6 public schools, 2 schools (18.2%) reported a 5-10% cost ratio, again each from the rural and urban settings; another 3 (27.3%) schools reported a 11-15% cost proportion, with 2 of the these schools from urban settings; and the last school (9.1%) stated a 16-20% of the school's total expenditure in the year. Most of the public schools are low cost, and all these schools stated that tuition fee was their main source of income for financing Internet connection. This therefore explains why there were a number of schools with diverse Internet access costs proportions that were determined by the number of students enrolled. Though one public school charged the highest tuition fee at USD 1,500; and spent 5-10% of their expenditure on Internet access due to the academic character of the school where only 30% of the students pay fees, while the other 70% are from needy backgrounds have costs of their education supported by an endowment fund.

Table 9. Schools' proportion of Internet costs as a percentage of total expenditure

Area	Proportion of Internet costs as a percentage of total expenditure	Category		Sub-Total
		Private	Public	
Rural	Less than 5%	1 (9.1%)	1 (9.1%)	2 (18.2%)
	5-10%	0 (0%)	1 (9.1%)	1 (9.1%)
	11-15%	0 (0%)	1 (9.1%)	1 (9.1%)
	16-20%	0 (0%)	1 (9.1%)	1 (9.1%)
	Sub-Total	***1 (9.1%)***	***4 (36.4%)***	***5 (45.5%)***
Urban	Less than 5%	2 (18.2%)	1 (9.1%)	3 (27.3%)
	5-10%	0 (0%)	1 (9.1%)	1 (9.1%)
	11-15%	0 (0%)	2 (18.2%)	2 (18.2%)
	Sub-Total	***2 (18.2%)***	***4 (36.4%)***	***6 (54.5%)***
Total		**3 (27.3%)**	**8 (72.7%)**	**11 (100%)**

4.1.2 Usage Indicators

4.1.2.1 Access to ICTs

All the schools sampled had ICT facilities such as computers, printers, scanners, CD writers and computer speakers available and accessible to its students and teachers. The only exception were 2 private schools located in Nakuru and Nairobi, where all the teachers had lap tops in addition to the computers in the offices allocated to them. As can be seen from Table 3 the ratio of students to computers was on average 5:1 in private schools as compared to the 20:1 in public schools. The average number of computers in the private schools in both rural and urban settings were 60; and 35 in the rural based and 45 in urban based public schools.

Table 10 illustrates the responses of the schools sampled as regards where in the school the computers are located. In all the schools sampled the computers and other related facilities are located in the school laboratories where students access them, and in the administrators' offices. Four (36.4%) schools indicated that the computers and related facilities were also located in the teachers' lounges. Three (27.3%) schools also indicated that the computers and other related facilities were located in the classrooms, the departmental heads' offices and the student health centre.

Table 10. Location of computers and other related facilities in schools

Area	Where are the school's computers and other related resources located?	Category		Sub-Total
		Private	Public	
Rural	Computer lab, teachers' lounge & administrator's office	0 (0%)	2 (18.2%)	2 (18.2%)
	Computer lab, teachers' lounge, administrator's office & library	1 (9.1%)	1(9.1%)	2 (18.2%)
	Computer lab, administrator's office & library	0 (0%)	1(9.1%)	1 (9.1%)
	Sub-Total	***1 (9.1%)***	***4 (36.4%)***	***5 (45.5%)***
Urban	Computer lab, classroom, teachers' lounge, administrator's office & library	1 (9.1%)	0 (0%)	1 (9.1%)
	Computer lab, teachers' lounge, administrator's office , library & student health centre	1 (9.1%)	0 (0%)	1 (9.1%)
	Computer lab, administrator's office & departmental heads' offices	0 (0%)	3 (27.3%)	3 (27.3%)
	Computer lab, administrator's office & library	0 (0%)	1 (9.1%)	1 (9.1%)
	Sub-Total	***2 (18.2%)***	***4 (36.4%)***	***6 (54.5%)***
Total		**3 (27.3%)**	**8 (72.3%)**	**11 (100%)**

Table 11(a) is a cross tabulation of the schools' responses as regards the proportion of students and teachers with access to computers and related facilities. As can be seen, nine schools (82%) had more than 75% of its students accessing computers and related facilities at school; one school (9%) which was publicly funded and rural based had between 51% and 75% of its students with access to the computers and another one school (9%) which was publicly funded and urban based reported that 10-25% of its students actually accessed the computers and other related facilities. In the case of the two schools mentioned above with less than 75% of its students accessing the computers; it was interesting to note that one of the schools did not have computers located in the teachers' lounge where they could be accessed more effectively, and both schools were girls' only schools with equally low access rates in terms of the proportion of teachers with access to the schools' computers.

It seemed also that the rates of access for both teachers and students in the schools irrespective of their cost basis were similar.

Table 11 (a). Students and teachers access rates to schools' computers and related facilities

Cost level	Area	Access Rates	Students		Sub Total	Teachers		Sub Total
			Private	Public		Private	Public	
Low	Rural	10-25%	0	0	0	0	1 (9.1%)	1 (9.1%)
		51-75%	0	1 (9.1%)	1 (9.1%)	0	0	0
		Over 75%	1 (9.1%)	3 (27.3%)	4 (36.4%)	1 (9.1%)	3 (27.3%)	4 (36.4%)
		Sub-Total	***1 (9.1%)***	***4 (36.4%)***	***5 (45.5%)***	***1 (9.1%)***	***4 (36.4%)***	***5 (45.5%)***
	Urban	10-25%	0	1 (9.1%)	1 (9.1%)	0	0	0
		26-50%	0	0	0	0	1 (9.1%)	1 (9.1%)
		Over 75%	0	1 (9.1%)	1 (9.1%)	0	1 (9.1%)	1 (9.1%)
		Sub-Total	***0***	***2 (18.2%)***	***2 (18.2%)***	***0***	***2 (18.2%)***	***2 (18.2%)***
Medium	Urban	26-50%	0	0	0	0	1 (9.1%)	1 (9.1%)
		Over 75%	0	2 (18.2%)	2 (18.2%)	0	1 (9.1%)	1 (9.1%)
		Sub-Total	***0***	***2 (18.2%)***	***2 (18.2%)***	***0***	***2 (18.2%)***	***2 (18.2%)***
High	Urban	Over 75%	2 (18.2%)	0	2 (18.2%)	2 (18.2%)	0 (0%)	2 (18.2%)
		Sub-Total	***2 (18.2%)***	***0 (0%)***	***2 (18.2%)***	***2 (18.2%)***	***0 (0%)***	***2 (18.2%)***
Total			***3 (27.3%)***	***8 (72.7%)***	***11 (100%)***	***3 (27.3%)***	***8 (72.7%)***	***11 (100%)***

It also seemed there was a significant and positive linear correlation between the proportions of teachers and proportions of students accessing the computers at schools, and measuring this relationship using the Pearson correlation coefficient yielded the following results as shown in Table 11 (b);

Table 11 (b). Pearson correlation coefficient on students and teachers access to computers

		Proportion of student with access to computers	Proportion of teachers with access to computers
Proportion of student with access to computers	Pearson Correlation	1	0.623(*)
	Sig. (2-tailed)	0.000	0.040
	N	11	11
Proportion of teachers with access to computers	Pearson Correlation	0.623(*)	1
	Sig. (2-tailed)	0.040	0.000
	N	11	11

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

Table 12 cross tabulates the responses of the schools as to the level of access to the use of ICT facilities by the students and teachers. Interestingly, it is only 3 schools (27.3%) that stated the ICT facilities were always accessible after school hours; a majority at 6 schools (54.5%) stated that the ICT facilities were sometimes available; a school (9.1%) stated the facilities were accessible at a fee and possibly to generate additional income as it is a low cost school; and another school (9.1%) stated the facilities were never accessible. There seems to have been no relation with the school's category or area settings.

Table 12. Students and teachers' accessibility to the use of ICT facilities after school hours

Cost Level	Area	Do students and teachers have access to use of ICT facilities after school hours?	Category		Sub-Total
			Private	Public	
Low	Rural	They are sometimes accessible	1 (9.1%)	3 (27.3%)	4 (36.4%)
		They are accessible for a fee	0	1 (9.1%)	1 (9.1%)
		Sub-Total	***1(9.1%)***	***4 (36.4%)***	***5 (45.5%)***
	Urban	They are sometimes accessible	0	1 (9.1%)	1 (9.1%)
		They are always accessible	0	1 (9.1%)	1 (9.1%)
		Sub-Total	***0***	***2 (18.2%)***	***2 (18.2%)***
Medium	Urban	No, they are never accessible	0	1 (9.1%)	1 (9.1%)
		They are sometimes accessible	0	1 (9.1%)	1 (9.1%)
		Sub-Total	***0***	***2 (18.2%)***	***2 (18.2%0***
High	Urban	They are always accessible	2 (18.2%0	0	2 (18.2%0
		Sub-Total	***2 (182%)***	***0***	***2 (18.2%0***
Total			**3 (27.3%)**	**8 (72.7%)**	**11 (100%)**

4.1.2.2 Enhancing education with ICTs

Table 13 shows that out of the 11 schools sampled, 6 (54.5%) schools stated that more than 75% of their teachers had basic ICT literacy skills. Another 3 (27.3%) schools indicated that 51-75% of their teachers had some basic ICT literacy skills and the remaining 2 schools (18.2%) showing less than 50% of their teachers had any basic literacy skills in ICT. The school that indicated 10-25% of their teachers possessing basic ICT skills had also indicated that 10-25% of its teachers had access to the school's computers, implying that lack of adequate access could be responsible for the low ICT literacy skills levels. There was no correlation between rural and urban based schools, or between publicly and privately funded schools with the ICT literacy skills.

Table 13. Teachers' basic ICT literacy levels

Area	Proportion of teachers with basic ICT literacy skills	Category		Total
		Private	Public	
Rural	10-25%	0 (0%)	1 (20%)	1 (20%)
	51-75%	1 (20%)	1 (20%)	2 (40%)
	Over75%	0 (0%)	2 (40%)	2 (40%)
	Sub-Total	***1(20%)***	***4 (80%)***	***5 (100%)***
Urban	26-50%	0 (0%)	1 (16.7%)	1 (16.7%)
	51-75%	0	1 (16.7%)	1 (16.7%)
	Over 75%	2 (33.4%)	2 (33.4%)	4 (66.8%)
	Sub-Total	***2(33.4%)***	***4 (66.6%)***	***6 (100%)***
Total		**3 (27.3%)**	**8 (72.7%)**	**11 (100%)**

The schools' use of computers and related technologies in the different classes or subjects are summarized in Table 14 (a). The highest use of computers in any class was in the ICT subjects, where 90.9% of the schools use computers "always" in the class. In order to determine the use of computers in each of the class, a scale of 5 weighted items was adapted: 4=always; 3=a lot; 2=sometimes; 1=rarely and 0=never and this was used to compute the classes or subject usage index.

Table 14 (a). Classes or subjects in schools that computers are used in teaching

Classes or subjects (i)		Level of use (f=frequency)				
	Usage level	Always	A lot	Sometimes	Rarely	Never
	Weight (w)	4	3	2	1	0
ICT subjects		10 (90.9%)	1(9.1%)	0	0	0
Mathematics		0	1 (9.1%)	9 (81.8%)	1 (9.1%)	0
Science		1 (9.1%)	1 (9.1%)	8 (72.7%)	1 (9.1%)	0
Social sciences		1 (9.1%)	1 (9.1%)	3 (27.3%)	5 (45.5%)	1 (9.1%)
English		1 (9.1%)	3 (27.3%)	3 (27.3%)	4 (36.3%)	0
Art		0	5 (45.5%)	1 (9.1%)	4 (36.3%)	1 (9.1%)
Music		3 (27.3%)	2 (18.2%)	0	4 (36.3%)	2 (18.2%)

The formula used in generating the weighted subject usage index was;

$$\text{Usage Index} = \frac{\sum_{i=1}^{n} w_i f_i}{\sum_{i=1}^{n} f_i} \qquad \text{.....eq. 4}$$

The items, the usage index and the variances are summarized and listed in Table 14 (b). From the table it can therefore be implied that the order of subjects from the most frequently used to least frequently used as regards computer usage were: the ICT subjects, the Sciences, English, Mathematics, Music, Art and the Social sciences. There seemed to be no relation as regards the schools on rural or urban settings.

Table 14 (b): Ranking of teachers' usage index in descending order

Classes or subjects	Usage Index	Variance
ICT subjects	3.91	0.091
Science	2.18	0.564
English	2.09	1.091
Mathematics	2.00	0.200
Music	2.00	2.600
Art	1.91	1.291
Social sciences	1.73	1.418

The responses of the schools to the 5 items when asked to ascertain the purposes of use of Internet as regards the teachers are summarized in Table 15 (a). Again, and in order to determine the use of computers in each of the class, a scale of 4 weighted items was adapted: 1=0-25%; 2=26-50%; 3=51-75%; and 4=76-100% and this was used to compute the purposive index.

The formula used in generating the weighted subject usage index was;

$$\text{Purposive Index} = \frac{\sum_{i=1}^{n} w_i f_i}{\sum_{i=1}^{n} f_i} \qquad \text{.....eq. 5}$$

Table 15 (a). Teachers' purpose of Internet usage in the schools

The school uses the Internet for:	**0-25%**	**26-50%**	**51-75%**	**76-100%**
Weight (w)	1	2	3	4
Learning enrichment or learning new things	3 (27.3%)	2 (18.2%)	3 (27.3%)	3 (27.3%)
Regular instruction and training for developing computer skills	2 (18.2%)	4 (36.4%)	3 (27.3%)	2 (18.2%)
Finding/accessing information	0 (0%)	1 (9.1%)	6 (54.5%)	4 (36.4%)
Communicating with others	1 (9.1%)	3 (27.3%)	4 (36.4%)	3 (27.3%)
As teaching/learning tool for specific subjects	3 (27.3%)	2 (18.2%)	4 (36.4%)	2 (18.2%)

Table 15 (b). Ranking of teachers' purposive index in descending order

Purpose of Internet usage	**Purposive Index**	**Variance**
Finding/accessing information	3.27	0.418
Communicating with others	2.82	0.964
Learning enrichment or learning new things	2.70	1.344
Regular instruction and training for developing computer skills	2.45	1.073
As teaching/learning tool for specific subjects	2.45	1.273

From Table 15 (b) the findings disclose that more than 75% of the teachers made use of Internet most for finding and/or accessing information. This was followed by communication with others through email; learning enrichment or learning new things; regular instruction and training for developing computers; with the least use as teaching and learning tools for specific subjects with about 60% of

the teachers in the schools. Again, there does not seem to be any relationship with schools on the basis of area settings i.e. rural or urban based.

4.1.3 Policy and Strategy Indicators

4.1.3.1 ICT strategy

Seven schools (63.6%) indicated that they have an ICT code of conduct to regulate use of computers and the Internet in the schools.

4.1.3.2 ICT financing

A majority of the schools disclosed that they financed the costs of Internet connectivity through tuition fee, with 8 schools (72.7%) responding to this source. The rest of the 3 schools each financed their Internet connectivity through the PTAs, school levies and other non-tuition and non-levy sources. This is summarized in Table 16 below.

Table 16. Sources of financing for Internet connectivity in schools

Sources of payment for Internet connectivity	Frequency	Percent
the school through tuition fee	8	72.7%
Non-Tuition fees and non-levies	1	9.1%
PTAs	1	9.1%
school levies	1	9.1%
Total	**11**	**100%**

4.2 School teachers

From Table 17 it can be seen that among the teachers sampled 58 (59.2%) were female, and 40 (40.8%) were male. Majority of the teacher respondents were in the 30-40 years age group with 57 (58.2%) teachers. This was followed by 21 teachers (21.4%) in the 40-50 years age group; 17 teachers (17.3%) in the under 30 years age group and finally the least represented with 3 teachers in the 50

years + age group. When years of service worked was considered, most of the teachers were in the 5-10 years of service group with 27 teachers (27.6%); followed by 24 teachers (24.5%) in the 11-14 years group; 22 teachers (22.4%) in the 15-20 years group; 21 teachers (21.4%) in the less than 5 years of service group, and the least being 4 teachers (4.1%) with 20 years + service in the teaching profession. Fifty one (52%) teachers had an undergraduate degree as their highest educational qualification; followed by 30 teachers (30.6%) with a diploma qualification and 17 teachers (17.3%) with a postgraduate qualification.

Table 17. Profile of the teachers sampled

		Frequency	Percent
Gender	Female	58	59.2%
	Male	40	40.8%
Age	Under 30 years	17	17.3%
	30-40 years	57	58.2%
	40-50 years	21	21.4%
	50 years +	3	3.1%
Years of service	Less than 5 years	21	21.4%
	5-10 years	27	27.6%
	11-14 years	24	24.5%
	15-20 years	22	22.4%
	20 years +	4	4.1%
Educational qualifications	Diploma	30	30.6%
	Undergraduate	51	52%
	Postgraduate	17	17.3%

4.2.1 Usage Indicators

4.2.1.1 Developing the ICT workforce

From Table 18 it can be seen that 43 (43.9%) teachers had more than 6 years of using computers, while 11 (11.2%) teachers had less than a year of experience on use of computers. When comparison of the teachers on the school setting was made, there was no obvious relationship between the factors noted. But it seemed there was a reasonable difference among teachers based on gender, especially when it was observed that the proportion of female teachers with more than 4 years of using computers was 52% as compared to 70% of the male teachers.

Table 18. Teachers' usage of computers by gender and number of years

Gender	How many years have you been using computers?	Area Setting		Sub-Total
		Rural	Urban	
Male	< 1 yr	1 7.7%	3 11.1%	4 10.0%
	1-2 yrs	2 15.4%	2 7.4%	4 10.0%
	2-4 yrs	1 7.7%	3 11.1%	4 10.0%
	4-6 yrs	5 38.5%	3 11.1%	8 20.0%
	6 yrs +	4 30.8%	16 59.3%	20 50.0%
	Sub-Total	***13*** ***32.5%***	***27*** ***67.5%***	***40*** ***100%***
Female	< 1 yr	4 14.3%	3 10.0%	7 12.1%
	1-2 yrs	7 25.0%	2 6.7%	9 15.5%
	2-4 yrs	5 17.9%	7 23.3%	12 20.7%
	4-6 yrs	4 14.3%	3 10.0%	7 12.1%
	6 yrs +	8 28.6%	15 50.0%	23 39.7%
	Sub-Total	***28*** ***48.3%***	***30*** ***51.7%***	***58*** ***100%***
Total		**41** **41.8%**	**57** **58.2%**	**98** **100%**

Majority of the teachers did not receive any ICT training during their formative years at the teacher training colleges or universities before joining the teaching profession as shown in Table 19. About 55% of the teachers stated that they did not receive any ICT training at all. But interestingly, 51% of the teachers had received some ICT training over the past 3 years they had been employed in the teaching profession.

Table 19. ICT training opportunities for the teachers

	Did you receive any ICT training before joining the teaching profession?		Did you receive any ICT training over the past 3 years?	
	Frequency	Percent	Frequency	Percent
Yes	44	44.9%	50	51%
No	54	55.1%	48	49%

But on closer observation of the cross tabulation when gender is introduced, it seemed women generally have not had as much ICT training opportunities in the past 3 years as compared to the males as shown on Table 20.

Table 20. Cross tabulation of gender and training in ICT recently for teachers

			Gender		Total
			Male	Female	
ICT training in the past 3 years	Yes	Number of teachers	22 (55.0%)	28 (48.3%)	50 (51.0%)
	No		18 (45.0%)	30 (51.7%)	48 (49.0%)
Total		**Count**	**40**	**58**	**98**

When asked to state the main reasons for attending the ICT training, a majority of teachers (58.2%) said it was personal growth. This was followed by 49% who said it was for career enhancement; 14.3% who said that training was required by the school; and least 4% who said motivation for financial benefits in form of pay rises. The responses of the teachers are summarized in Table 21;

Table 21. Reasons for ICT training by teachers

What are the main reasons for you attending the ICT training?	Number of teachers	Percent
Financial	4	4.1%
Career enhancement	46	49.0%
Personal growth	57	58.2%
Training is required	14	14.3%

The summarized responses are illustrated in a pie chart in Figure 3.

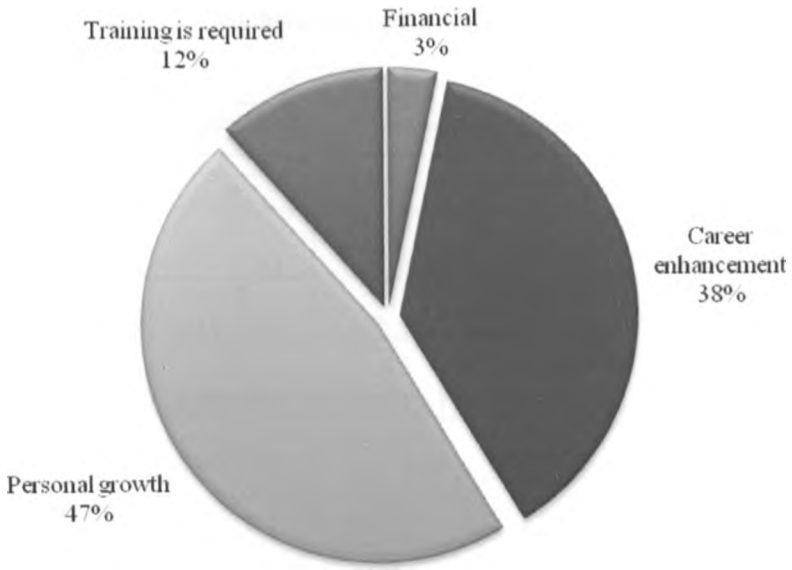

Figure 3. Reasons for ICT training by teachers

Majority of the teachers, about 77% had rated themselves as having "Good" to "Excellent" expertise levels in use of word processing applications, with the least expertise noted in web page design applications. The teachers' responses are summarized in Table 22 (a). But in order to determine the level of expertise in each of the different applications, a scale of 5 was assigned to each expertise level: 0=No capability; 1=Fair; 2=Good; 3=Very good and 4=Excellent.

Based on this scale, a weighted index was calculated using the formulae previously (see equation 4) adapted to derive an expertise index level for the applications, and rank them accordingly as shown in Table 22 (b).

It is apparent therefore that the levels of expertise in word processing is on average 'Very good", followed by Spreadsheets, Emailing, Internet browsing, Presentation, Statistical, Graphics, Database management systems and least in Web page designing.

Table 22 (a). Teachers' expertise levels in software applications

Software application	Excellent	Very good	Good	Fair	No Capability
Weight (w)	4	3	2	1	0
Word processing	25 (25.5%)	24 (24.5%)	26 (26.5%)	20 (20.4%)	3 (3.1%)
Spreadsheets	17 (17.3%)	12 (12.2%)	24 (24.5%)	29 (29.6%)	16 (16.3%)
Presentation tools	20 (20.4%)	15 (15.3%)	24 (24.5%)	20 (20.4%)	19 (19.4%)
Emailing	35 (35.7%)	22 (22.4%)	18 (18.4%)	12 (12.2%)	11 (11.2%)
Internet browsing	37 (37.8%)	22 (22.4%)	21 (21.4%)	10 (10.2%)	8 (8.2%)
Graphics	15 (15.3%)	3 (3.1%)	19 (19.4%)	22 (22.4%)	39 (39.8%)
Statistical tools	8 (8.2%)	4 (4.1%)	16 (16.3%)	28 (28.6%)	42 (42.9%)
Web page designing	5 (5.1%)	5 (5.1%)	4 (4.1%)	16 (16.3%)	68 (69.4%)
Database management	8 (8.2%)	4 (4.1%)	7 (7.1%)	26 (26.5%)	53 (54.1%)

Table 22 (b). Ranking of teachers' expertise levels in descending order

Software application	Expertise Index	Standard deviation
Word processing	2.07	0. 922
Spreadsheets	1.92	1.266
Emailing	1.89	1.044
Internet browsing	1.88	0. 911
Presentation tools	1.72	1.182
Statistical tools	1.33	1.449
Graphics	1.32	1.344
Database management	0.97	1.327
Web page designing	0.61	1.127

There was no linear relationship between the expertise levels of teachers with types of schools on the basis of area settings.

4.2.2 Individuals and Society Indicators

4.2.2.1 ICTs in everyday life

Majority of the teachers had a computer and access to the Internet at their schools. The availability of the computers was 98% and access to the Internet was 82.7% at the schools. It was also interesting to note that 53.1% of the teachers had computers at home, with 23.5% of the teachers with access to the Internet. It was also identified that 78.6% of the teachers had access to cyber cafes and 36.7% through ICT training centres that offered short term courses during the school recess (as shown in Table 23 and illustrated in Figure 4).

Table 23. ICT facilities available and accessible for teachers

	Computer		Internet connection	
	Frequency	**Percent**	**Frequency**	**Percent**
At schools	96	98%	81	82.7%
At home	52	53.1%	23	23.5%
At commercial places e.g. cyber cafe	77	78.6%	77	78.6%
At ICT training centres	36	36.7%	36	36.7%

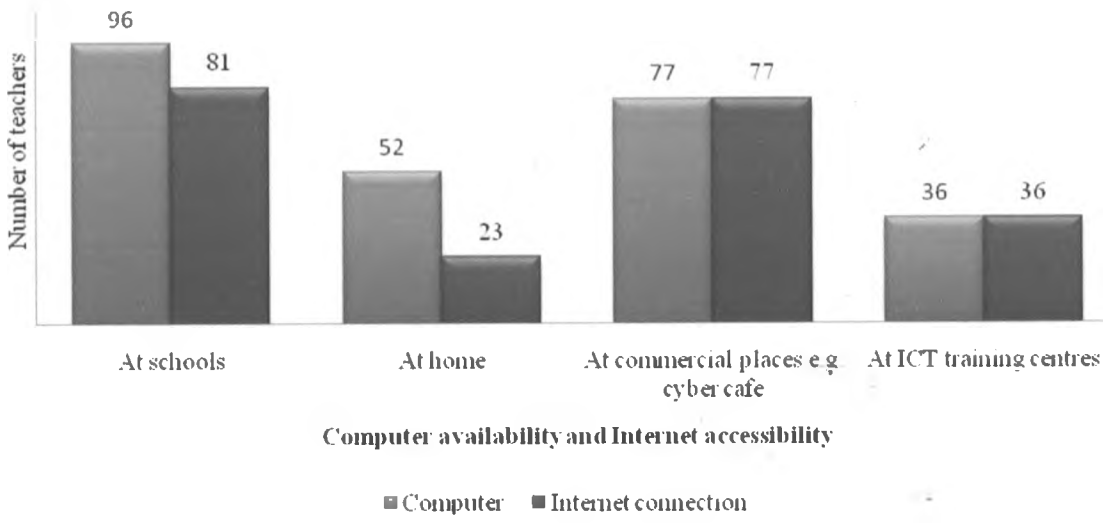

Figure 4. Illustration of the computer and internet accessibility for teachers

Seventy three (74.5%) teachers had access to computers at the schools' computer laboratories. This was followed by access to computers located at the administrators' officers with 29 (29.6%) teachers responding; 25 (25.5%) teachers for both the teachers' lounge and their offices; and 12 (12.2%) teachers who had access at the libraries. Of the teachers who responded that they had access to the computers at their offices, majority were from the private schools that had computers available to their teachers and staff in offices, with departmental heads in some public schools also accessing them at their offices. As can be seen from Table 24, it seems efforts are being made to install computers in the teachers' lounge for accessibility by the teachers who cannot access them in their offices nor through the laboratories in the privately sponsored schools.

Table 24. Location of teachers' accessibility to computers

Area	Where do you use computers in school?	Category		Total
		Private	Public	
Rural	No response	0 (0%)	1 (2.4%)	1 (2.4%)
	Teachers' lounge	1 (2.4%)	4 (9.8%)	5 (12.2%)
	Teachers' lounge, my office, administrators' office & library	0 (0%)	1 (2.4%)	1(2.4)
	Teachers' lounge, my office, administrators' office, computer lab & library	2 (4.9%)	0 (0%)	2 (4.9%)
	Teachers' lounge, administrators' office & computer lab	0 (0%)	1 (2.4%)	1 (2.4%)
	Teachers' lounge & computer lab	0 (0%)	4 (9.8%)	4 (9.8%)
	My office	1 (2.4%)	0 (0%)	1 (2.4%)
	My office, administrators' office & computer lab	0 (0%)	1 (2.4%)	1 (2.4%)
	My office, administrators' office, computer lab & library	1 (2.4%)	0 (0%)	1 (2.4%)
	Administrators' office	0 (0%)	1 (2.4%)	1 (2.4%)
	Administrators' office & computer lab	1 (2.4%)	5 (12.2%)	6 (14.6%)
	Administrators' office, computer lab & library	1 (2.4%)	0 (0%)	1 (2.4%)
	Computer lab	1 (2.4%)	15 (36.6%)	16 (39%)
	Sub-Total	***8 (19.5%)***	***33 (80.5%)***	***41 (100%)***
Urban	Teachers' lounge	1 (2%)	1 (0%)	2 (3.5%)
	Teachers' lounge & my office	1 (2%)	0 (0%)	1 (2%)
	Teachers' lounge, my office, administrators' office & computer lab	1 (2%)	0 (0%)	1 (2%)
	Teachers' lounge, my office, administrators' office, computer lab & library	1 (2%)	0 (0%)	1 (2%)
	Teachers' lounge, my office & computer lab	1 (2%)	0 (0%)	1 (2%)
	Teachers' lounge, my office, computer lab & library	1(2%)	0 (0%)	1 (2%)
	Teachers' lounge, my office & library	1 (2%)	0 (0%)	1 (2%)
	Teachers' lounge & computer lab	2 (3.5%)	1 (2%)	3 (5.9%)
	Teachers' lounge, computer lab & library	1 (2%)	0 (0%)	1 (2%)
	My office	0 (0%)	4 (7.8%)	4 (7.8%)
	My office, administrators' office, computer lab & library	0	1 (2%)	1 (2%)
	My office & computer lab	1 (2%)	6 (11.8%)	7 (13.8%)
	My office, computer lab & library	1 (2%)	0 (0%)	1 (2%)
	Administrators' office	0	6 (11.8%)	6 (11.8%)
	Administrators' office & computer lab	1 (2%)	5 (9.8%)	6 (11.8%)
	Computer lab	2 (3.9%)	16 (31.4%)	18 (35.3%)
	Library	2 (3.9%)	0 (0%)	2 (3.9%)
	Sub-Total	***17 (33.3%)***	***40 (66.7%)***	***57 (100%)***
Total		**25 (25.5%)**	**73% (74.5%)**	**98 (100%)**

Majority of the teachers, about 40% in both rural and urban settings indicated that they had more than 10 hours in a week of access to the school computers. But when an in depth analysis was made on the

basis of the schools' ownership, it was apparent that the teachers from private schools enjoyed far much higher access than their counterparts from the public schools. In both rural and urban settings, and when considering the public schools, there was a skew observed towards access of up to 2 hours where 20-29% of the teachers were found. The responses of the teachers to this accessibility of computers are summarized in Table 25 with proportion of teacher based on the schools' categories.

Table 25. Computer accessibility to teachers in hours per week

Area setting	Duration of computers accessibility	Private		Public		Sub Total	Percent
		f	Percent	*f*	Percent		
Rural	< 1 hr	1	12.5%	7	21.2%	8	19.5%
	1-2 hrs	0	0%	5	15.2%	5	12.2%
	2-4 hrs	0	0%	4	12.1%	4	9.8%
	4-6 hrs	0	0%	4	12.1%	4	9.8%
	6-10 hrs	1	12.5%	2	6.1%	3	7.3%
	10 hrs +	6	75.0%	11	33.3%	17	41.5%
	Sub-Total	***8***	***100.0%***	***33***	***100.0%***	***41***	***100.0%***
Urban	< 1 hr	0	0%	10	25.0%	10	17.5%
	1-2 hrs	0	0%	7	17.5%	7	12.3%
	2-4 hrs	1	5.9%	4	10.0%	5	8.8%
	4-6 hrs	0	0%	6	15.0%	6	10.5%
	6-10 hrs	3	17.6%	3	7.5%	6	10.5%
	10 hrs +	13	76.5%	10	25.0%	23	40.4%
	Sub-total	***17***	***100.0%***	***40***	***100.0%***	***57***	***100.0%***
Total		**25**	**25.5%**	**73**	**74.5%**	**98**	**100%**

4.2.2.2 People and organizations online

Almost all the teachers sampled from the connected schools had a functional email address with 91(91.8%) teachers responding. Table 26 shows the summarized responses from the teachers while Figure 5 illustrates this in a pie chart.

Table 26. Proportion of teachers with email addresses

Do you own:	Email address	
	Frequency	Percent
Yes	90	91.8%
No	8	8.2%

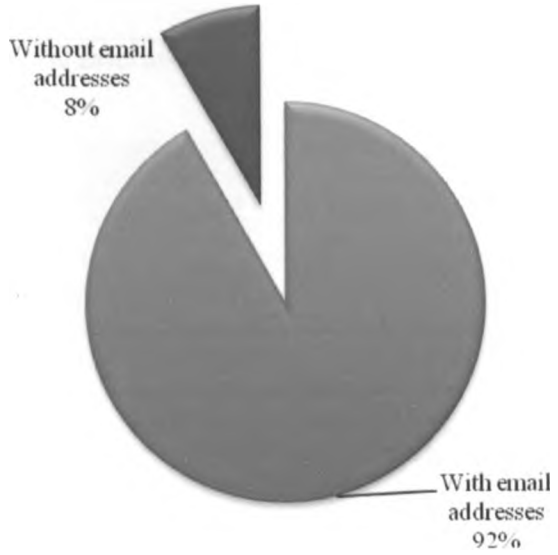

Figure 5. Teachers' email addresses ownership

When comparison was made between teachers based on rural and urban settings, and between private and public schools; some differences in the teachers' frequency of use of the Internet was observed. Based on rural and urban settings, it was discernible that teachers from urban areas had a higher frequency in use of the Internet than teachers from the rural based schools. The responses of the teachers are summarized in Table 27. The same difference is also noticeable between private and public schools, as a majority of teachers from private schools used it on a daily basis compared to their counterparts from the public schools.

Table 27. Teachers' frequency of Internet use at school

Area setting	How often do you use Internet at school?	Private		Public		Sub Total	Percent
		f	Percent	*f*	Percent		
Rural	Never	1	12.5%	8	25.0%	9	22.5%
	Once a month	0	0%	6	18.8%	6	15.0%
	Once a week	3	37.5%	9	28.1%	12	30.0%
	Several times a week	0	0%	6	18.8%	6	15.0%
	Everyday	4	50.0%	3	9.4%	7	17.5%
	Sub-Total	***8***	***100.0%***	***32***	***100.0%***	***40***	***100.0%***
Urban	Never	0	0%	7	17.5%	7	12.3%
	Once a month	0	0%	10	25.0%	10	17.5%
	Once a week	0	0%	7	17.5%	7	12.3%
	Several times a week	2	11.8%	10	25.0%	12	21.1%
	Everyday	15	88.2%	6	15.0%	21	36.8%
	Sub-Total	***17***	***100.0%***	***40***	***100.0%***	***57***	***100.0%***
Total		**25**	**25.5%**	**73**	**74.5%**	**98**	**100%**

4.2.2.3 Locally relevant content

The level of access to locally relevant content by the teachers was low as only 18.4% said they had access to local web-based training programmes. When were asked whether there were any local web portals they visited, only 24.5% teachers gave indication that they visited such sites. It appeared that the issue of availability of locally relevant content still ranked low. Table 28 represents the teachers' responses on the topic.

Table 28. Access to locally relevant content by teachers

Do you:	Have access to local web based training programmes?		Visit any local web portals?	
	Frequency	Percent	Frequency	Percent
Yes	18	18.4%	24	24.5%
No	80	81.6%	74	75.5%

4.2.2.4 ICTs in schools

The most common use of the Internet in teaching and learning by teachers was for preparing paper and teaching materials, with 46.9% of the respondents indicating this use as shown on Table 29. The second most common use was for collecting handouts and reference materials with 43.9% of the teacher respondents in this category. Other uses were for preparing lessons (28.6%); preparing presentations (28.6%) and teaching specific lessons in various subjects (27.6%). The least common use was for communicating with students (13.3%), and communicating with teachers (20.4%). It did not seem there was any relationship between teachers and the type of the schools where they were based.

Table 29. Teachers' use of Internet in teaching and learning

Internet usage among teachers	Number of teachers	Percent
For preparing paper and teaching materials	46	46.9%
For collecting handouts and reference materials	43	43.9%
For preparing presentations	28	28.6%
For preparing lessons	28	28.6%
For teaching specific lessons in various subjects	27	27.6%
For communicating with teachers	20	20.4%
For communicating with students	13	13.3%

4.3 School students

4.3.1 Individual and society indicators

4.3.1.1 Access to ICTs

Majority of the students sampled from these schools had access to ICT tools and facilities for use in their subjects, with 509 (73.7%) students saying they had access to the same. The responses of the students are summarized in Table 30, and which indicated that across gender there did not seem to be any significant differences in access of ICT tools by students. But when in depth analysis is made across the school types, it appears that schools in the rural areas register much lower rates (40-60%) compared to urban based schools (67-100%).

Table 30. Use of ICT in subject work by gender and school type

	Gender	Do you use ICT in your school subjects?	Category		Sub Total
			Private	Public	
Rural	**Male**	Yes	6 (40.0%)	43 (66.2%)	49 (61.3%)
		No	9 (60.0%)	21 (33.8%)	30 (37.5%)
		Sub-Total	***15 (100.0%)***	***65 (100.0%)***	***80 (100.0%)***
	Female	Yes	9 (60.0%)	105 (56.8%)	114 (57.0%)
		No	6 (40.0%)	80 (43.2%)	86 (43.0%)
		Sub-Total	***15 (100.0%)***	***185 (100.0%)***	***200 (100.0%)***
Urban	**Male**	Yes	67 (95.7%)	48 (66.7%)	115 (81.0%)
		No	3 (4.3%)	23 (33.3%)	26 (18.3%)
		Sub-Total	***70 (100.0%)***	***72 (100.0%)***	***142 (100.0%)***
	Female	Yes	57 (100.0%)	174 (82.1%)	231 (85.9%)
		No	0 (0%)	38 (17.9%)	38 (14.1%)
		Sub-Total	***57 (100.0%)***	***212 (100.0%)***	***269 (100%)***

As was indicated previously in Table 10, all the schools had computers located in the computer laboratories, and this was where almost all the students accessed the computers at school with 664 (96.1%) students indicating so, and their responses are summarized in Table 31. The next common location was the library with 75 students (10.9%) saying they had access to the computers; followed by the dormitories with 26 students (3.8%). In the case of students who responded by stating that they had access to the computers at the libraries and the dormitories, it was observed that all the students were from private schools.

Table 31. Students' use of computers and its location in schools

Location of computer use	Number of students	Percent
In a classroom	6	0.9%
In a computer lab	664	96.1%
In both classrooms and laboratory	21	3.0%
In the library	75	10.9%
Dormitories	26	3.8%

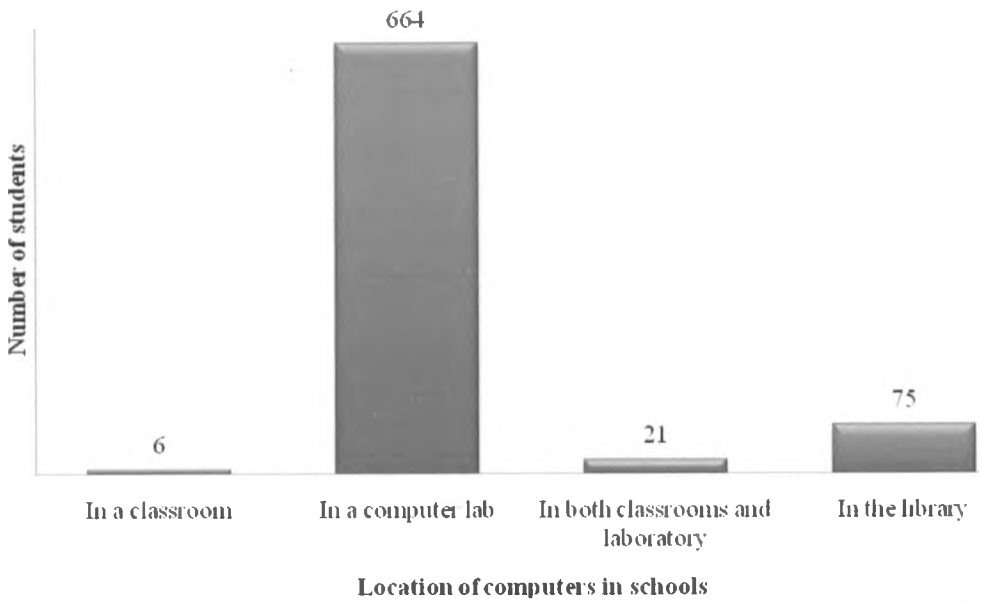

Figure 6. Illustration of students' use of computers and its location in schools

It can thus be concluded that by far the most common location of computers in schools is still the computer laboratory. Though schools are beginning to install computers in the libraries especially where digital libraries are being used to supplement the traditional library.

The responses from the students regarding the number of years they had been using computers are summarized in Table 32. It is shown that 16.5% of the students had less than a year's experience, and this is due to the fact that a majority of the students entering their first year of study at the secondary

school education system are encountering ICT. However, 63.5% of the students had more than 2 years of experience using computers, with 27.8% students saying they had over 6 years indicating that this particular group of students exited from primary schools which had ICT in education well entrenched in their curricula. Closer observation of the cross tabulated data however indicates that rural based schools have students with far much lower experience levels, and it is even more apparent when considering gender indicating girls are still disadvantaged especially in the public schools. But the gender disparities disappear in private and urban based schools with more investment in ICT and better teacher and computer to student ratios.

Table 32. Cross tabulation of school types, gender and years of computer use by students

	Gender	Years using computers	School type		Sub Total
			Private	Public	
Rural	**Male**	< 1 yr	2 (13.3%)	2 (3.1%)	4 (5.0%)
		1-2 yrs	4 (26.7%)	6 (9.2%)	10 (12.5%)
		2-4 yrs	7 (46.7%)	19 (29.2%)	26 (32.5%)
		4-6 yrs	1 (6.7%)	15 (23.1%)	16 (20.0%)
		6 yrs +	1 (6.7%)	23 (35.4%)	24 (30.0%)
		Sub-Total	***15 (100.0%)***	***65 (100.0%)***	***80 (100.0%)***
	Female	< 1 yr	3 (20.0%)	44 (23.8%)	47 (23.5%)
		1-2 yrs	4 (26.7%)	54 (29.2%)	58 (29.0%)
		2-4 yrs	4 (26.7%)	49 (26.5%)	53 (26.5%)
		4-6 yrs	3 (20.0%)	17 (9.2%)	20 (10.0%)
		6 yrs +	1 (6.7%)	21 (11.4%)	22 (11.0%)
		Sub-Total	***15 (100.0%)***	***185 (100.0%)***	***200 (100.0%)***
Urban	**Male**	< 1 yr	0 (0%)	20 (27.8%)	20 (14.1%)
		1-2 yrs	3 (4.3%)	19 (26.4%)	22 (15.5%)
		2-4 yrs	3 (4.3%)	21 (29.2%)	24 (16.9%)
		4-6 yrs	9 (12.9%)	6 (8.3%)	15 (10.6%)
		6 yrs +	55 (78.6%)	6 (8.3%)	61 (43.0%)
		Sub-Total	***70 (100.0%)***	***72 (100.0%)***	***142 (100.0%)***
	Female	< 1 yr	4 (7.0%)	39 (18.4%)	43 (16.0%)
		1-2 yrs	1 (1.8%)	47 (22.2%)	48 (17.8%)
		2-4 yrs	6 (10.5%)	53 (25.0%)	59 (21.9%)
		4-6 yrs	3 (5.3%)	31 (14.6%)	34 (12.6%)
		6 yrs +	43 (75.4%)	42 (19.8%)	85 (31.6%)
		Sub-Total	***57 (100.0%)***	***212 (100.0%)***	***269 (100.0%)***

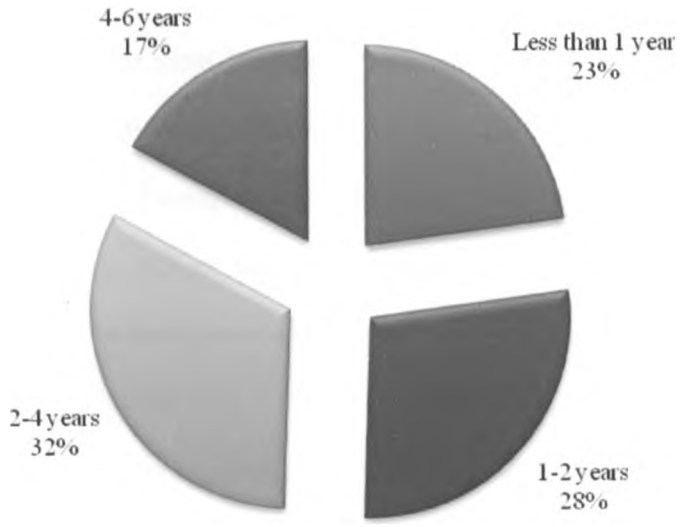

Figure 7. Illustration of students' experience with computers

Majority of students in the schools are still taught ICT by the teachers, and 467 (67.6%) of the students indicated so. But interestingly, a significant proportion of students (24%) stated that family members have also been responsible for their ICT training, implying that an increasing number of Kenyan families are owning computers at home and transferring skills to their children. Also worth noting is the fact that some parents are taking their children for ICT training at commercial colleges during recess, and some of the schools are beginning to experiment with the idea of help desks and online courses through e-learning platforms such as Moodle. Table 33 represents these summarized responses of the students.

Table 33. How students were taught use of computers

Who taught you about computers?	Number of students	Percent
My teachers	467	67.6%
My family	166	24.0%
I have taught myself	156	22.6%
My friends	87	12.6%
Other students	48	7.0%
Training outside of schools	43	6.2%
Online courses or helpdesk	7	1.0%

4.3.1.2 ICTs in school

Computer science class is still the most common subject taught using ICTs, with about 90% of the student respondents citing the subject. Table 34 summarizes the students' responses as regards in which classes or subjects they used computers and related ICTs. From the responses it can be shown that the next most used ICTs in subject were the Sciences, that consist of physics, chemistry and biology which 17.5% of the students indicated that they use in this subject category; Mathematics with 9.4%; Music with 7.7%; English with 7.0%; art with 5.4% and least used in social sciences that consist of geography, history, economic, business education among others at 5.2%.

Table 34. Students' use of ICT in their classes

Subjects or classes	Number of students	Percent
Computer class	619	89.6%
Sciences	121	17.5%
Mathematics	65	9.4%
Music	53	7.7%
English	48	7.0%
Art	37	5.4%
Social sciences	36	5.2%

Majority of the students in the schools, about 77% had rated themselves as being "Very Good" in use of word processing applications, with the least expertise noted in web page designing (0.91) and developing web pages for school work (0.82), similar to the teachers' responses and the students' responses summarized in Table 35 (a). But in order to determine the level of expertise in each of the different applications, a scale of 5 was assigned to each expertise level: 0=No capability; 1=Fair; 2=Good; 3=Very good and 4=Excellent, similar to when determining the teachers' expertise levels in computer applications.

Based on this scale, a weighted index was calculated again using the formulae below to derive an expertise index for the applications, and ranked them accordingly as shown in Table 35 (b).

$$\text{Expertise index} = \frac{\sum_{i=1}^{n} w_i f_i}{\sum_{i=1}^{n} f_i} \quad \text{....eq. 6}$$

It is apparent therefore that the level of expertise in word processing at 'Very good" is the highest ranked in terms of expertise, followed by Internet browsing, Emailing, Chatting, Spreadsheets, Presentation tools, Graphics, Database management, Programming, Web page designing and least in developing basic and static webpage for schoolwork.

Table 35 (a). Students' expertise levels in software applications

Computer applications	**Excellent**	**Very good**	**Good**	**Fair**	**No capability**
	←				
Weight (w)	**4**	**3**	**2**	**1**	**0**
Word processing	217 (31.4%)	196 (28.4%)	164 (23.7%)	57 (8.2%)	49 (7.1%)
Spreadsheets	111 (16.1%)	156 (22.6%)	189 (27.4%)	101 (14.6%)	126 (18.2%)
Presentation tools	108 (15.6%)	122 (177%)	155 (22.4%)	130 (18.8%)	167 (24.2%)
E-mailing	223 (32.3%)	129 (18.7%)	111 (16.1%)	71 (10.3%	147 (21.3%)
Internet browsing	282 (40.8%)	134 (19.4%)	84 (12.2%)	70 (10.1%)	116 (16.8%)
Graphics	70 (10.1%)	95 (13.7%)	139 (20.1%)	123 (17.8%)	255 (36.9%)
Web page designing	30 (4.3%)	56 (8.1%)	99 (14.3%)	134 (19.4%)	363 (52.5%)
Chatting	205 (29.7%)	117 (16.9%)	89 (12.9)	73 (10.6%)	200 (28.9%)
Database development and management	44 (6.4%)	95 (13.7%)	136 (19.7%)	119 (17.2%)	289 (41.8%)
Developing basic and static webpage for schoolwork	22 (3.2%)	62 (9.0%)	83 (12.0%)	123 (17.8%)	394 (57.0%)
Programming	61 (8.8%)	76 (11.0%)	98 (14.2%)	121 (17.5%)	327 (47.3%)

Table 35 (b). Ranking of students' expertise levels in descending order

Software application	Expertise Index	Standard deviation
Word processing	2.70	1.203
Internet browsing	2.58	1.513
Emailing	2.31	1.541
Chatting	2.08	1.626
Spreadsheets	2.04	1.329
Presentation tools	1.82	1.397
Graphics	1.42	1.374
Database management	1.25	1.304
Programming	1.16	1.36
Web page designing	0.91	1.127
Developing basic & static webpage for schoolwork	0.82	1.149

As can be seen from Table 36 (a), the student respondents indicated that their main purpose for ICT use in school work was for informative purpose which involved finding, acquiring and using the information in their assignments. The proportion of students who used ICT everyday for this purpose was 15.5%; with 35.2% stating that they use it often; 13.3% occasionally; 14.3% rarely and 20.4% who never used it all in their schoolwork. This was followed by use of ICT for creative purposes, which involved writing papers, making PowerPoint presentation and oral presentations as major activities, with 9.4% saying they used it every day for this purpose; 23.6% often; 20.1% occasionally; 14.5% rarely and a substantial 31% who never used it at all for the purpose.

Next in terms of common use of purpose was communication. The activities here were exchanges and transmission of information with other students, teachers and others using email and Internet, joining discussion forums, social networks and chatting. Students who used ICT resources for this purpose everyday were 13.5%; those who stated they use it often were 15.2%, those who use it occasionally were 14%, those who rarely use it were 10.3% and those who never use it at all were 45.2% of the total. The least used was for functional purposes that involved compiling lists of books, summarize books and materials, and use the accessed information to prepare homework and comparing information. Here, 4.8% of the students indicated that they use ICT resources everyday for this purpose; 18.5% on often use; 15.2% on occasional use; 12.7% on rarely use and 47.2% who never use it at all.

Worth noting was that the two purposive categories: functional and communication, rely on the students accessing the Internet in order to fulfil the purposes, and due to the time constraint imposed on the students in the schools accessing the Internet, there was a significant proportion of students (at 47.2% and 45.2%) who never used the ICT resources available for these purposes. In comparison, the other two purposive categories: informative and creative, do not necessarily require the students accessing the Internet, as the activities can be carried out offline hence the low proportion of the students (at 20.4% and 31% respectively) who stated that they never used the ICT resources available for the purposes.

Table 36 (a). Purpose and degree of ICT use by students in schoolwork

Purpose	**Very often (everyday)**	**Often (twice or more in a week)**	**Occasionally (once in a month)**	**Rarely (once in several months)**	**Never**
Weight (w)	**4**	**3**	**2**	**1**	**0**
Informative: to find, acquire and use information	107 (15.5%)	243 (35.2%)	92 (13.3%)	99 (14.3%)	141 (20.4%)
Functional: compile lists of books, summarize books and materials, use accessed information to prepare homework, compare information	33 (4.8%)	128 (18.5%)	105 (15.2%)	88 (12.7%)	326 (47.2%)
Creating: write papers, programming, make PowerPoint presentations, give oral presentations, prepare newsletter, create own website etc	65 (9.4)	163 (23.6%)	139 (20.1%)	100 (14.5%)	214 (31.0%)
Communication: exchange and to transmit information with other students, teachers and others using email and Internet, join discussion forums, social networks and chat	93 (13.5%)	105 (15.2%)	97 (14.0%)	71 (10.3%)	312 (45.2%)

Again, in order to determine the degree of ICT use in schoolwork by the students, a scale of 5 was assigned to degree of use: 0=Never; 1=Rarely; 2=Occasionally; 3=Often and 4=Very often. Based on

this scale, a weighted index on degree of ICT use in schoolwork by the students was calculated using the formulae below to, and ranked them accordingly as shown in Table 36 (b).

$$\text{Degree of use} = \frac{\sum_{i=1}^{n} w_i f_i}{\sum_{i=1}^{n} f_i} \qquad \text{....eq. 7}$$

It is therefore apparent that highest degree of ICT in schoolwork by the students was for informative purpose (2.11); followed by creative purpose (1.65); communication purpose (1.40) and least in functional purpose (1.20).

Table 36 (b). Ranking of degree of use by students in schoolwork in descending order

Software application	**Degree of use**	**Standard Deviation**
Informative	2.11	1.395
Creating	1.65	1.382
Communication	1.40	1.516
Functional	1.20	1.337

The most favourite activity when using computers among the students was surfing the Internet (65.7%); and this can somehow be linked to the second most favourite activity that is information seeking (63.4%). This list of favourite activities as stated by the students is shown in Table 37 that have been ranked from the most favourite to the least favourite, and illustrated in Figure 9. This is followed next by playing computer games (61.5%); downloading music (56.9%); emailing of friends as a communication tool (55.1%); and chatting online using various tools such as MSN, Yahoo! and Jabber (48.2%). Interestingly there were student respondents who stated that they use Facebook as a social networking tool though this was a mere 1.3% of the students sampled. The least favourite activities were watching movies (0.3%) and making animations (0.1%).

Table 37. Students' favourite activities when using computers

What are your favourite activities when using computers?	Number of students	Percent
Surfing the Internet	454	65.7%
Finding information	438	63.4%
Playing games	425	61.5%
Downloading music	393	56.9%
Emailing	381	55.1%
Chatting	333	48.2%
Using educational software	191	27.6%
Writing papers	74	10.7%
Preparing presentations	72	10.4%
Programming	62	9.0%
Others-Facebook	9	1.3%
Others-Watching movies	2	0.3%
Others-making animations	1	0.1%

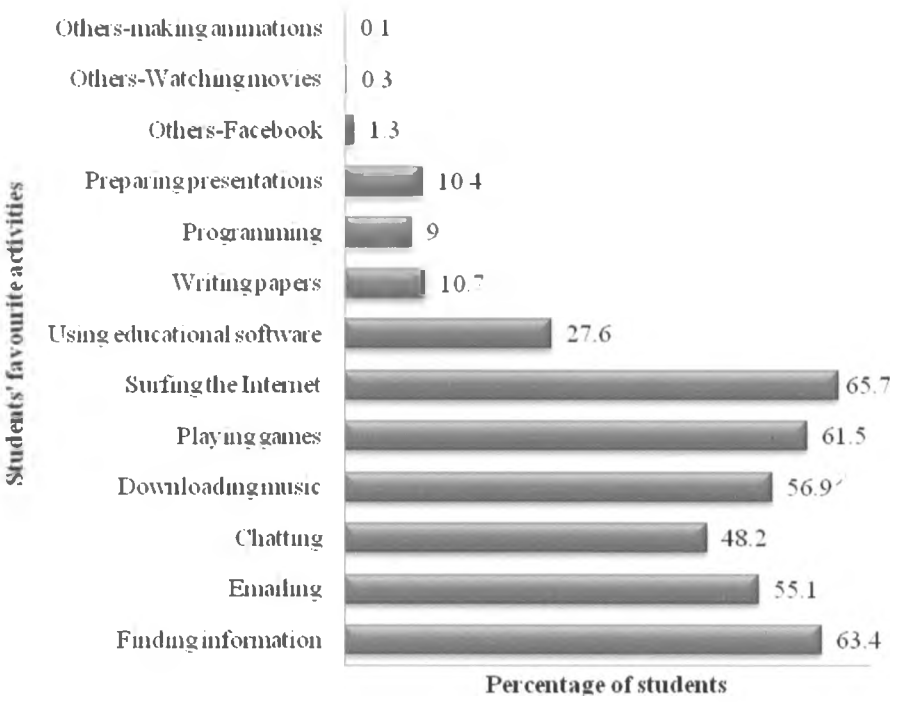

Figure 8. Students' favourite activities when using computers

Majority of the students in the secondary schools had less than 5 normal school hours in a week of access to the computers and related ICTs in their studies, with 535 (77.4%) saying so. Another 95 (13.7%) students had 6-10 hours per week of access; 29 (4.2%) students with 11-15 hours per week

14 (2%) students with 16-20 hours and 12 (1.7) students with more than 20 hours in a week of access to the computers. The responses of the students have been summarized in Table 38.

Table 38. Students' access to computers of normal school hours per week

Hours per week	Number of students	Percent
Less than 5 hours	535	77.4%
6-10 hours	95	13.7%
11-15 hours	29	4.2%
16-20 hours	14	2.0%
20 hours +	12	1.7%

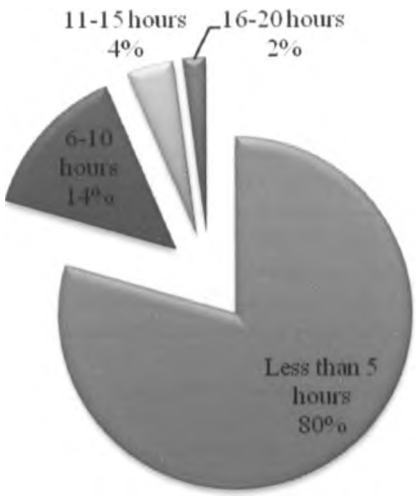

Figure 9. Illustration of students' access to computers of normal school hours per week

4.3.1.3 People and organizations online

Majority of the students, at 435 (63%) of them had access to the Internet in the schools as shown on Table 39 (a). But on closer observation of the cross tabulated data below it seemed that students from the private schools and schools from urban areas had higher levels of Internet access for the students. This is supported by the statistical tests of bivariate correlation run on the data that supported a correlation that is negative.

Table 39 (a). Students' accessibility to the Internet

	Do you have access to the Internet?	Private		Public		Sub-Total	
		f	Percent	*f*	Percent	*f*	Percent
Rural	Yes	22	73.3%	133	53.8%	155	56.0%
	No	8	26.7%	114	46.2%	122	44.0%
	Sub-Total	***30***	***100.0%***	***247***	***100.0%***	***277***	***100.0%***
Urban	Yes	125	100.0%	155	55.2%	280	69.0%
	No	0	0%	126	44.8%	126	31.0%
	Sub-Total	***125***	***100.0%***	***281***	***100.0%***	***406***	***100.0%***

Table 39 (b). Pearson correlation coefficient on schools' area setting and students 'access to Internet

		Area setting	Access to Internet
Area setting	Pearson Correlation	1	-0.133(**)
	Sig. (2-tailed)	.	0.001
	N	691	683
Access to Internet	Pearson Correlation	-0.133(**)	1
	Sig. (2-tailed)	0.001	.
	N	683	683

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

The same pattern was observed when students were asked to state their frequency of the use of Internet for surfing, with students from the private schools and urban based schools having higher levels of Internet access for the students' frequency of Internet use for surfing compared to the students from public and rural based schools as shown in Table 40.

Table 40. Frequency of Internet use for surfing

	How often do you use the Internet for surfing at school?	Private		Public		Sub-Total	
Rural		*f*	**Percent**	*f*	**Percent**	*f*	**Percent**
	Very often	0	0%	3	1.2%		
	Often	2	6.7%	30	12.2%	32	11.6%
	Occasionally	9	30.0%	30	12.2%	39	14.1%
	Rarely	4	13.3%	43	17.5%	47	17.0%
	Never	15	50.0%	140	56.9%	155	56.2%
	Sub-Total	***30***	***100.0%***	***246***	***100.0%***	***276***	***100.0%***
Urban	Very often	36	29.0%	3	1.1%	39	9.7%
	Often	62	50.0%	57	20.4%	119	29.5%
	Occasionally	16	12.9%	39	13.9%	55	13.6%
	Rarely	9	7.3%	60	21.4%	69	17.1%
	Never	1	0.8%	121	43.2%	122	30.2%
	Sub-Total	***124***	***100.0%***	***280***	***100.0%***	***404***	***100.0%***

Table 41. Pearson correlation coefficient on access levels to Internet and use on surfing

		Access to Internet	Internet use for surfing
Access to Internet	Pearson Correlation	1	0.610(**)
	Sig. (2-tailed)	.	0.000
	N	683	680
Internet use for surfing	Pearson Correlation	0.610(**)	1
	Sig. (2-tailed)	0.000	.
	N	680	680

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

The statistical tests on bivariate correlations (shown on Table 41) supported the view that there was a significant and positive correlation between access to the Internet and its frequency of use for surfing among students in the schools.

It is interesting to note that a majority of the students, 500 (72.4%) of the total sampled indicated that they owned a mobile phone, though most of the schools surveyed were boarding schools and did not allow students to carry phones to school. Also interesting was the fact that 444 (64%) of these students sampled had an email address that was functional, with only 52 (7.5%) students stating they

had a personal webpage, which most likely might be a social networking tool such as Facebook or a blog. Of the 500 students who owned mobile phones, when asked to state whether they used the phones for accessing the Internet and or emailing, 365 students (73%) of them said they used the mobile phones for Internet surfing and emailing. This implies that about 52% of the total students sampled actually used their mobile handsets to access the Internet and even send and receive emails. This is summarized in Table 42.

Table 42. Student's ownership-mobile phones, email addresses and personal websites

Do you:	Do you own a mobile phone?		Do you have an email address?		Do you have a personal webpage	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Yes	500	72.4%	444	64.3%	52	7.5%
No	191	27.6%	247	35.7%	639	92.5%

The summaries of the Table 42 are illustrated in Figure 11.

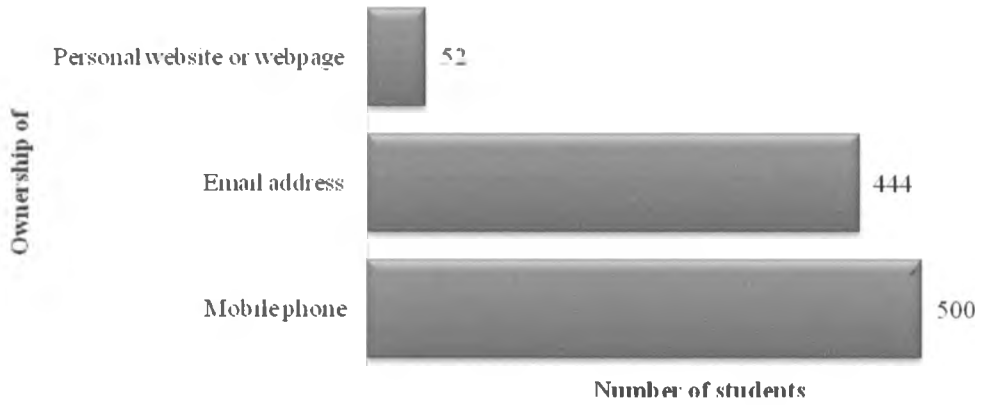

Figure 10. Illustration of students' ownership-mobile phones, email addresses and personal websites

In terms of the frequency of use and sending email (disregarding use of mobile phones for this purpose) among the students, 25.9% responded by saying that they use it often; another 18.7% used it

occasionally; another 16.6% rarely used email and 13.2% considered themselves daily users. This is summarized in Table 43.

Table 43. Students' frequency of email use

Frequency of email use	**Number of students**	**Percent**
Very often (everyday)	91	13.2%
Often (twice or more in a week)	179	25.9%
Occasionally (once in a month)	129	18.7%
Rarely (once in several months)	115	16.6%
Never	177	25.6%
Total	**691**	**100%**

CHAPTER FIVE

DISCUSSIONS, CONCLUSION AND RECOMMENDATIONS

Introduction

A cross sectional descriptive survey was conducted to address the following problem statements;

- What are the states of Internet connectivity and ICT tools in connected rural and urban secondary schools?
- What are the ICT training opportunities available for teachers?
- What are the Internet utilization profiles for connected rural and urban secondary schools?
- What are the strategies that can be used to promote effective use of ICT related technologies in secondary schools?

Though the benefits of ICTs on education are still inconclusive as regards Africa, reported observations have included rapid expansion of knowledge, improved examination outcomes, enhanced communication, technical proficiency and increased decentralization of education services. Uses of ICT and related technologies have been noted to have the potential of enhancing the quality of teaching and learning, and management and effectiveness of institutions (Kashorda, Waema, Omosa, & Kyalo, 2007). In order therefore to understand these perceived benefits, there is need to understand the extent of the utilization of ICTs and related technologies by investigating the factors that determine this utilization. Kenya has made progress by putting in place an ICT policy framework and implementation strategy, with most secondary schools having some computer equipment (Farrel, 2007) and adoption of computers that has progressed from acquisition of basic computer skills to usage in every subject (Ministry of Education, Kenya, 2006). This opinion is supported by findings of this study.

Discussions of main findings

This section is comprised of a summary of the research findings that were discussed in Chapter 4, and within the context of the conceptual framework that guided the research process.

5.1 Accessibility

5.1.1 Internet availability

Most of the schools (about 82%) sampled had Internet access of more than 40 hours in a month. Two (18%) schools reported less than 20 hours in a month of Internet access and this was attributed to non-networked computers in the school laboratories. The levels of Internet accessibility for both teachers and their students were high. For the teachers, accessibility to Internet at schools and homes were 81% and 23% respectively of the respondents surveyed. This was also high at 77% of the teacher respondents when accessing Internet at the cyber cafes. For the students' respondents, 435 (63%) students had access to the Internet at schools; with students from urban based and private schools seemingly having a higher access rate than their colleagues from rural-based and public schools.

5.1.2 Internet affordability

Majority of the schools sampled spent less than 5% of their annual expenditure on maintaining Internet connectivity, and it was observed that public schools spent up to 20% of their school expenditure. These schools were low cost and had the tuition fee as the main source of financing Internet connectivity.

5.2 Usage

5.2.1 Access to ICTs

All the schools sampled had ICT facilities that were available and accessible to the teachers and students, and it was observed that private schools had purchased lap tops for their teachers in some cases. As can be seen from Table 3 the students to computer ratios were 5:1 in private schools and 20:1 in public schools, with average numbers of computers in private schools from both rural and urban settings being 60 and in public schools both rural and urban based being 40. These findings

suggest that accessibility to ICT facilities at schools that are connected might be higher compared to schools that are not connected to Internet (Ministry of Education, Science & Technology, 2005). As determined in previous studies (Makau, 1990) accessibility to ICT facilities by students is still predominantly in the school laboratories, though this study has shown that private schools are having ICT facilities installed in school libraries, teachers' lounges, dormitories and even the school health centres. Overall, more than 75% of the students have access to these ICT facilities and this is a departure from the previous studies that indicated low rates of accessibility (Kenya SchoolNet, 2003).

5.2.2 Enhancing education with ICTs

It was observed that there were high levels of ICT integration into the subjects taught at the schools. Using the developed usage index, the study suggested that subjects such as ICT, sciences, English, Mathematics and Music used ICT facilities' for teaching and learning. More than 75% of the teachers made use of the Internet most for finding and accessing information, then for email; learning enrichment or learning new things; regular instruction and training for developing computers, with least use as teaching and learning tools for specific subjects.

5.2.3 Developing the ICT workforce

About 44% of the teachers had more than 6 years of experience in computer usage, with only 11% stating that they had less than 1 year computer usage. It seemed though that there was gender disparity, especially when observed that female teachers with more than 4 years of computer usage were 52% as compared to male teachers who were 70% of their populations. It was also found that 55% of the teachers did not receive any ICT training prior to joining the teaching profession, but nevertheless noted that half of them had had training in the past 3 years. This is supported by the view from the school heads that over 75% of their teachers could be regarded as having basic ICT literacy skills.

5.3 Individuals and Society

5.3.1 People and organizations online

Almost all the teachers (about 92%) in these connected schools had functional email addresses, with 64% of the students also indicating use of a functional email address. Interestingly 7.5% of the students said they had a personal webpage or blog, and references were made to social networking sites such as Facebook. A high proportion of students (73%) said they owned a mobile phone, with 52% of these students using the mobile phones for accessing Internet and sending and receiving emails.

5.3.2 Locally relevant content

The findings of the study suggested that there were low proportions of teachers (18.4%) with access to local web-based training programmes, and 24.5% of teachers with access to local web portals. This is attributed to the lack or inadequacy of locally relevant material online especially for ICT related courses that is also reflected in the approved school curricula.

5.4 Policy, Strategy and Financing

5.4.1 ICT strategy

About 64% of the schools had an ICT code of conduct to regulated use of computers and Internet among their users. But it was observed that not all the schools had adopted the national ICT strategy implemented by the Ministry of Education in 2002 so as to guide the process of ICT integration into education.

5.4.2 ICT financing

The study indicated that almost all the schools still relied on the tuition fees paid by the students to maintain their Internet connectivity, and for some public schools this was a challenge as reflected in their spending proportions of the annual school expenditure due to the ceiling set on what they could collect from the students. Based on whether the school was low, medium or high cost; it was observed that private schools were able to install, equip and maintain better ICT facilities as compared to public

schools due to the high fees they charge. Most of the public schools had been reliant on donor support through non-governmental support initiatives such as Computers for Schools-Kenya and NEPAD, with little or lack of financial support from the government to support the ICT initiatives.

Conclusion

The objective of the study was to help policy makers, decision makers and investors to make well informed decisions about public policy and investments in ICT as regards education at the secondary school level by understanding how the Internet and its related components (and by extension ICT in general) are utilized. The study showed the extent to which the Internet is utilized and identified the factors that enhance or impede its utilization at this level of education, and which can be used to explain the integration of Internet into the teaching and learning.

The findings of the study has shown that the use of Internet and its integration in the teaching and learning in secondary education is getting more widespread; and its use more pervasive students and teachers as a means of communication and for information searching being common; and the least use in some instances for course content delivery, assignments and continuous assessments. Access rates for teachers and students have been observed to be much higher in educational institutions that have made effective ICT investments in education, translating into better utilization of ICT related technologies with assumed positive impacts that another study can attempt to measure by understanding the linkages between utilization of the Internet and its impacts in education.

The study has also found that most of the schools are actually expending a substantial part of their annual budget on maintaining Internet connectivity, and this explains why it is estimated by the Ministry of Education that about 3% of the 6,566 secondary schools in Kenya have any form of Internet connectivity. But this could change with the enhancement of the competition regulatory framework as well as operationalization of the National Fibre Optic cable through the East African Submarine System (EASSY) project expected to boost Internet penetration and bring the cost of Internet connectivity down in the third quarter of 2009.

It was also found that there was a positive correlation between proportions of students and teachers accessing the schools' computers, and this was evident in girls only schools where it appeared that investments in ICT was low and resulting in gender disparity disadvantaging the girl child. This does not portend good news for the girls in the secondary schools, considering that there are 635,698 girls enrolled, constituting 46% of the country's 1,382,211 total student enrolment in secondary schools (Kenya National Bureau of Statistics , 2009). Though the study focussed on schools with Internet connectivity, the proportion of teachers with access to computers and internet at schools and homes was respectively 98% and 53% of the teachers sampled, implying that the affordable bundle rates and increased access to the mobile wireless broadband services is having an impact. According to the Communications Commission of Kenya (CCK) there were 392,964 mobile broadband users as at 31 December 2008 (Communications Commission of Kenya, 2009). Some of the schools sampled are addressing the issue of accessibility to computers by its teachers and students through use of Wi-Fi in the school localities. This is also reflected at the proportion of teachers and students with email addresses which are at 92% and 64% respectively, with 72% of the students owning mobile phones. Related to this findings, it has always been assumed that the most common place for students to access the computers has been the computer laboratories, though it appears that some schools, especially privately sponsored schools are focussing on the libraries with the intention of extending traditional libraries services to support digital resources.

The study also found that majority of the teachers did not receive ICT training at the teachers' training colleges or universities where they trained, with 55% getting into the teaching profession with no experience of computers and its related technologies. But it is reassuring to note that there seems to reversal of trends as with 51% of them indicating that they have undergone ICT training in the past 3 years, with some schools supporting the training programmes.

The levels of ICT literacy skills levels were found to high in both students and teachers than was expected in the schools with Internet connectivity. The index levels that were computed for the expertise levels in the most commonly used software applications also supported this finding, and the

same was noted for the purpose of Internet in the school work among students with weighted ratings of above 75%.

It can be concluded that use of ICT and its related technologies is still at its early stages of its development and implementation, and hence an inadequate and divergent use of curricula in the secondary schools depending on the system of education and which was not responsive to the fast changing ICT landscape, for instance examining students in open source software like Ubuntu®. Though it is worth noting that in some instances there is evidence of development of e-content with the relevant local material content by the Kenya Institute of Education (KIE) in use for the Form 1s and 2s students.

Recommendations

The study has provided a starting point for investigating the impact of the Internet usage and utilization in Kenyan secondary schools. While the study has useful information, further research should be conducted so as to obtain more concise information on the usage and utilization of the Internet, particularly for some of the indicators used in the conceptual framework adapted for this study. It would be interesting to investigate further the links between penetration, utilization and impact of the Internet within the ICT realm and develop an assessment model out of the conceptual framework for use in assessing these links and its outcomes in secondary schools of Kenya. This can be extended to look at secondary schools that are both connected and unconnected to the Internet with the view of making comparative analysis of the factors that determine use of ICT and related technologies, though it is expected that most of the indicators would demonstrate lower levels of availability and accessibility to ICT facilities.

The factors that determine Internet utilization in both rural and urban secondary schools have hopefully been established in this study. However, secondary schools in Kenya can effectively utilize the Internet to improve educational outcomes by adopting the following recommended strategies:

1. ICT access and accessibility
    - Facilitate greater access to ICT and its related components by students and teachers in secondary schools by the school administration.
    - Recognize the need for adequate power supply so as to provide ICT access to all schools, especially in rural areas so as to reduce the "rural urban digital divide" and thereby increase Internet penetration.
2. Human resources and training
    - Train schools' principals, teachers and ICT support staff on proper use of the Internet and its applications.
3. Policy environment
    - Recognize need for monitoring and evaluation to support the development and delivery of ICT in the education sector.
    - Adoption of the ICT national policy of 2002 to provide a regulatory and implementation framework for ICT in education related projects.
4. Financing and ICT investment
    - Recognize and promote the need for Public-Private Partnerships (PPPs) in addressing key ICT in education challenges in the country so as to supplement the Government's efforts.
5. Curriculum development and locally relevant content
    - Facilitate increased locally relevant content to meet the needs of students and teachers in secondary schools.
    - Harmonize the different curricula offered to schools and update to reflect technological changes in ICT and other related specialties, and recognize use of open source software that can cut down on software license fees.

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APPENDIX I
Survey Instrument-Part I for Heads of Schools

General

1. Date:_____

2. Name of School:_____

3. Address:

P.O. Box	
Telephone	
Fax	
Email	
Website	
District	

4. Type of area where school is located:

☐ urban ☐ semi-urban ☐ rural

5. Type of School

☐ public ☐ private

6. Enrolment totals:

Male	
Female	

7. Total number of school personnel (includes teaching, non-teaching and administrative)

Teaching	
Non-Teaching	
Administrative	

A. Accessibility Indicators

Internet Availability

8. Describe your Internet connection arrangement with your ISP (Internet Service Provider) and indicate speed/bandwidth. (Please check all that apply).

	Speed/bandwidth
☐ dial up	_____
☐ dedicated dial up	_____
☐ leased line	_____
☐ ISDN/DSL	_____
☐ Wireless	_____
☐ mobile GPRS/EDGE	_____

9. How many hours in a month does your school access the Internet?

☐ Less than 4 hours ☐ 5-20 hours ☐ 21-40 hours ☐ More than 40 hours

10. How many computers are connected to the Internet either as:

Stand alone _____ Networked _____

Internet Affordability

11. What is the total cost of your Internet access as a percentage of the total expenditure to your school per year?

☐ Less than 5% ☐ 5-10% ☐ 11-15% ☐ 16-20% ☐ 21-25% ☐ More than 25%

B. Usage Indicators

Access to ICTs

12. Please check under the appropriate column if the following ICT facilities are available in school. If Yes, state number of units.

	Available		Number of Units
	Yes	No	
PC	☐	☐	
Laptop	☐	☐	
Handheld/PDA	☐	☐	
Printer	☐	☐	
Scanner	☐	☐	
CD writer	☐	☐	
Computer Speaker	☐	☐	

13. Where are the computers located in school?

☐ computer laboratory

☐ classroom

☐ teachers' lounge

☐ administrator's office

☐ library

☐ others (please specify) _____

14. How many students have access to the school's computers?

☐ Less than 10% ☐ 10-25% ☐ 26-50% ☐ 51-75% ☐ Over 75%

15. How many teachers have access to the school's computers?

☐ Less than 10% ☐ 10-25% ☐ 26-50% ☐ 51-75% ☐ Over 75%

16. Do your teachers and students have access to the use of ICT facilities after school hours?

- ☐ No, they are never accessible
- ☐ They are sometimes accessible
- ☐ They are always accessible
- ☐ They are accessible for a fee

Enhancing education with ICTs

17. How many teachers have basic ICT literacy skills?

☐ Less than 10% ☐ 10-25% ☐ 26-50% ☐ 51-75% ☐ Over 75%

18. In which classes or subjects in your school are computers and related technologies are used?

	ALWAYS	A LOT	SOMETIMES	RARELY	NEVER
ICT subject	☐	☐	☐	☐	☐
Mathematics	☐	☐	☐	☐	☐
Science	☐	☐	☐	☐	☐
Social Sciences	☐	☐	☐	☐	☐
English	☐	☐	☐	☐	☐
Art	☐	☐	☐	☐	☐
Music	☐	☐	☐	☐	☐

19. For what purposes do your school use Internet? Please reply to each only if there is about 25-100% of the total teachers doing it

	0-25%	26-50%	51-75%	76-100%
Learning enrichment or learning new things	☐	☐	☐	☐
Regular instruction and training for developing computer skills	☐	☐	☐	☐
Finding/accessing information	☐	☐	☐	☐
Communicating with others	☐	☐	☐	☐
As teaching/learning tool for teaching specific subjects	☐	☐	☐	☐
Others (please specify)	☐	☐	☐	☐

C. Policy & Strategy Indicators

20. Does your school have a code of conduct for use of computers and Internet

☐ Yes ☐ No

ICT financing

21. Who pays for the Internet connection in your school?

☐ the school through tuition fee

☐ parent teacher association

☐ school levies

☐ others (please specify) _____

APPENDIX II

Survey Instrument-Part II for Teachers & Teaching Staff

General

1. Date:_____

2. Name of School:_____

3. Gender: ☐ Male ☐ Female

4. Age in years:

   ☐ Under 30 ☐ 30-40 ☐ 40-50 ☐ Over 50

5. Number of years in service:

   ☐ Less than 5 years ☐ 5-10 years ☐ 11-14 year ☐ 15-20 years ☐ Over 20 years

6. Please check your educational level:

Postgraduate degree	☐ Yes	☐ No
Undergraduate degree	☐ Yes	☐ No
Diploma	☐ Yes	☐ No

Specialization _____

C. Usage Indicators

Developing the ICT workforce

7. How many years have you been using computers?

   ☐ Less than one year

   ☐ 1-2 years

   ☐ 2-4 years

   ☐ 4-6 years

   ☐ More than 6 years

8. Did you receive any training on information and communications technology before you joined the teaching profession (pre-service)?

   ☐ Yes ☐ No

9. Did you receive any training in information and communication technology over the past 3 years?

   ☐ Yes ☐ No

10. What are your main reasons for attending computer training?

- ☐ Financial
- ☐ Career enhancement
- ☐ Personal growth
- ☐ Training is required
- ☐ Others (please specify) _____

11. Please rate your expertise in the use of the following:

	Excellent	Very Good	Good	Fair	No Capability
Word processing	☐	☐	☐	☐	☐
Spreadsheets	☐	☐	☐	☐	☐
Presentation tools (PowerPoint)	☐	☐	☐	☐	☐
E-mailing	☐	☐	☐	☐	☐
Internet browsing	☐	☐	☐	☐	☐
Graphics	☐	☐	☐	☐	☐
Statistical tools	☐	☐	☐	☐	☐
Web page designing	☐	☐	☐	☐	☐
Database management	☐	☐	☐	☐	☐

D. Individuals & Society Indicators

ICTs in Everyday Life

12. Please check under each column to indicate that you have/have no access to computers and whether the computers have access to the Internet in the following:

Location	Computer		Internet access	
	With access	No access	Yes	No
School	☐	☐	☐	☐
At home	☐	☐	☐	☐
Commercial places e.g. cyber	☐	☐	☐	☐
ICT training course centres	☐	☐	☐	☐
Others (please specify) _____	☐	☐	☐	☐

13. Where do you use computers in school?

- ☐ Teachers lounge
- ☐ In my office
- ☐ Administrator's office
- ☐ Computer laboratory
- ☐ Library
- ☐ Others (please specify) _____

14. How many hours per week are your school's computers accessible to you?

- ☐ Less than one
- ☐ 1-2
- ☐ 2-4
- ☐ 4-6
- ☐ 6-10
- ☐ More than 10

People and Organizations Online

15. Do you have an email address?

☐ Yes ☐ No

16. Do you maintain a personal web page as teaching tool?

☐ Yes ☐ No

17. If you have access to the Internet, how often do you use in the school?

- ☐ Never
- ☐ Once a month
- ☐ Once a week
- ☐ Several times a week
- ☐ Everyday

Locally relevant content

18. Do you have access to local web-based training programmes?

☐ Yes ☐ No

19. Are there any local web portals that you visit?

☐ Yes ☐ No

ICTs in schools

20. How do you use the Internet in your job as a teacher?

- ☐ For teaching specific lessons in various subjects
- ☐ For preparing presentations
- ☐ For preparing lessons
- ☐ For communicating with students
- ☐ For communicating with teachers
- ☐ For preparing paper and teaching materials
- ☐ For collecting handouts and reference materials
- ☐ Others (please specify)_____

APPENDIX III

Survey Instrument-Part III for Students

General

1. Date:_____
2. Name of School:_____
3. Grade/Year Level: _____
4. Gender: ☐ Male ☐ Female

A. Individuals & Society Indicators

Access to ICTs

5. In your school, are you able to use the required ICT tools and facilities that you need in doing your subject schoolwork?

   ☐ Yes ☐ No

6. Where do you use computers in school?

   ☐ In a classroom

   ☐ In a computer laboratory

   ☐ In both classrooms and laboratory

   ☐ In the library

   ☐ Others (please specify) _____

7. How many years have you been using computers?

   ☐ Less than one year

   ☐ 1-2 years

   ☐ 2-4 years

   ☐ 4-6 years

   ☐ More than 6 years

8. Who taught you about computers?

- ☐ I have taught myself
- ☐ My teachers
- ☐ My friends
- ☐ My family
- ☐ Other students
- ☐ Training outside of schools
- ☐ Online courses or helpdesk
- ☐ Others (please specify) _____

ICTs in schools

9. In which classes or subjects do you use computers and related ICTs?

- ☐ Computer class
- ☐ Mathematics
- ☐ Science
- ☐ Social Sciences
- ☐ English
- ☐ Art
- ☐ Music
- ☐ Others (please specify)_____

10. Please rate your expertise in the use of the following:

	Excellent	Very Good	Good	Fair	No Capability
Word processing	☐	☐	☐	☐	☐
Spreadsheets	☐	☐	☐	☐	☐
Presentation tools (PowerPoint)	☐	☐	☐	☐	☐
E-mailing	☐	☐	☐	☐	☐
Internet browsing	☐	☐	☐	☐	☐
Graphics	☐	☐	☐	☐	☐
Web page designing	☐	☐	☐	☐	☐
Chatting	☐	☐	☐	☐	☐
Database development and management	☐	☐	☐	☐	☐
Developing basic and static webpage for schoolwork	☐	☐	☐	☐	☐
Programming	☐	☐	☐	☐	☐

11. For what purpose and in what degree do you use ICT in schoolwork?

Purpose	Very Often (everyday)	Often (twice or more in a week)	Occasionally (once in a month)	Rarely (once in several months)	Never
Informative: to find, acquire and use information	☐	☐	☐	☐	☐
Functional: compile lists of books, summarize books and materials, use accessed information to prepare homework, compare information	☐	☐	☐	☐	☐
Creating: write papers, drawing, programming, make PowerPoint presentations, give oral presentations, prepare newsletter, create own website etc	☐	☐	☐	☐	☐
Communication: exchange and to transmit information with other students, teachers and others using email and internet, join discussion forums, social networks and chat	☐	☐	☐	☐	☐

12. What are your favourite activities using computers? (Check as many as applicable)

- ☐ Find information
- ☐ Email
- ☐ Chat
- ☐ Download music
- ☐ Play games
- ☐ Surf the Internet
- ☐ Use educational software
- ☐ Write papers
- ☐ Programming
- ☐ Prepare presentations using PowerPoint
- ☐ Others (please specify)_____

13. How many hours in the average per week of normal school hours are you able to use computers and related ICTs to your studies?

- ☐ Less than 5 hours
- ☐ 6-10 hours
- ☐ 11-15 hours
- ☐ 16-20 hours
- ☐ More than 20 hours

People and Organizations Online

14. Do you have access to the Internet?

☐ Yes ☐ No

15. How often do you use the Internet for surfing website at school?

- ☐ Very often (everyday)
- ☐ Often (twice or more in a week)
- ☐ Occasionally (once in a month)
- ☐ Rarely (once in several months)
- ☐ Never

16. Please indicate if you have any of the following?

- ☐ Mobile phone
- ☐ Email address
- ☐ Personal website/webpage

17. If you indicated that you own a mobile phone, do you use it for accessing Internet and email?

☐ Yes ☐ No

18. How often do you use and send email?

☐ Very often (everyday)

☐ Often (twice or more in a week)

☐ Occasionally (once in a month)

☐ Rarely (once in several months)

☐ Never