EVALUATION OF NEPAD'S PILOT E-SCHOOLS IN KENYA

A PhD Thesis

By

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ABSTRACT

This study was conducted to evaluate the success of the pilot phase of the NEPAD e-School project in Kenya. The specific objectives were to: establish the ICT infrastructure installed in the e-Schools and determine the infrastructure's quality, accessibility and suitability for enhancing teaching and learning; determine the effectiveness of the training imparted on teachers and students to enable them to constructively engage with the installed ICT infrastructure in teaching and learning; establish the extent to which e-School infrastructure is being used to enhance teaching and learning and provide health information; determine the extent to which e-School users (students and teachers) felt that the e-Schools were preparing students to function in the global economy; and establish the extent to which the e-School improves the efficiency of school management and the processes of teaching and learning.

The study employed survey research methodology. All six of the NEPAD e-Schools in Kenya were included. Chevakali High School, Isiolo Girls Secondary School, Maranda High School, Menengai Secondary School, Mumbi Girls Secondary School and Wajir Girls Secondary School and the teachers and students in those schools formed the study population. Of the 5,186 students and teachers, a representative sample of 1,508 was selected using probabilistic techniques that involved stratification based on the number of students in each school, the number in each class level (forms I, II, III and IV), and gender in the case of Menengai Secondary School. Data was collected using an observation schedule, interview schedule and questionnaire. Observations were made of the infrastructure installed in the e-Schools with specific attention to computer laboratories, computer hardware, networking accessories, and presentation and communication equipment. The interviews were conducted with the principals of the e-Schools and self-administered questionnaires were hand-delivered to students and teachers.

The collected data was edited and cleaned. An analysis of quantitative data was done using the Statistical Package for Social Sciences (SPSS) together with Microsoft Excel, while qualitative data was analyzed using content analysis. Descriptive statistics and non-parametric tests assisted with the rejection or acceptance of the hypotheses.

The study established that all six of the e-Schools had installed the basic computing facilities required for integrating ICT in teaching and learning. All the e-Schools had VSAT for internet access via satellite in computer laboratories in which a variable number of computers were installed. The computers were networked using structured cabling into a LAN, and the LANS were linked into a WAN through the VSATs. The computer laboratories also had smart televisions, smart boards and LCD projectors.

The study revealed that the conceptualized E-School Success Model is valid for the evaluation of the e-School. All seven of the dimensions were found to correlate well with e-School success, with Cronbach's alpha values above 0.4. It was further revealed that students and teachers were trained in the use of e-School infrastructure and they were using the ICT infrastructure for teaching and learning. Students found learning with integrated ICT enjoyable, and it appeared to improve their performances. Using document analysis, performance improvement was confirmed in four out of six of the e-Schools. The other two e-Schools experienced decline in academic performance over the period 2005 and 2010. It also seemed as though e-School infrastructure had enabled students and teachers to collaborate and had contributed to their teamwork skills.

By testing hypotheses the study revealed that six of the seven dimensions of the E-School Success Model contribute towards the success of the e-School. It was established that the user satisfaction dimension does not contribute towards the success of the e-School. Three variables for measuring the user satisfaction dimension - the ability of the e-School system to facilitate discussion between students, their peers and teachers; sharing what students learn with the learning community; and overall satisfaction with the e-School - were poorly rated and could not support the rejection of the hypothesis that high user satisfaction does not contribute to the success of the e-School.

The study concluded that the E-School Success Model is a good model for the evaluation of e-Schools. In addition, the NEPAD e-School project in Kenya has considerable potential for success. Having identified the aspects limiting its level of success, it was recommended that stakeholders

should continue investing in the NEPAD e-School project as the gaps highlighted in the study are addressed. Further studies on the impact of e-School benefits are recommended.

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DEDICATION

This study is dedicated to the Creator of Mankind. He provides for all, and provided me with health, energy and endurance. I also dedicate this work to my family. To Beldine Atieno Oluoch (Mrs. Ochieng'), I appreciate you filling the gap to take care of my three sons during my long absence. To my sons Preston, Bonn and Keilly, thank you for maintaining discipline even when I was far away. This thesis should encourage you to always exceed your expectations.

DECLARATION

I hereby declare that this thesis, submitted to the University of Zululand in fulfillment of the academic requirements for the award of the Doctor of Philosophy in Information Studies, is an original work done by me. I also declare that the work has neither been submitted nor copied elsewhere and that all the sources that were used in the thesis have been duly acknowledged.

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LIST OF ABBREVIATIONS

CAI: Computer Aided Instruction

CIPP: Context, Input, Process and Product

COL: Commonwealth of Learning

D&M: DeLone and McLean

ICT: Information and Communication Technologies

IS: Information Systems

ISP: Internet Service Provider

KENET: Kenya Educational Network Trust

LAN: Local Area Network

MOU: Memorandum of Understanding

NEPAD: New Partnership for African Development

PBL: Problem-based Learning

RASCOM: Regional African Satellite Communication Organization

SPSS: Statistical Package for Social Scientists

UK: United Kingdom

USAID: United States of Agency for International Development

VSAT: Very Small Aperture Terminal

WAN: Wide Area Network

CHAPTER ONE

INTRODUCTION

1.1 Research Background

The New Partnership for Africa's Development (NEPAD), through its organ of e-Africa Commission, is spearheading the development of information and communication technology (ICT) infrastructure on the African continent. The organ was specifically mandated to manage the structured development of the ICT sector on the African continent (NEPAD, 2005). This mandate entailed six priority projects including: the NEPAD e-School initiative; the low-cost satellite access project for NEPAD's electronic schools (e-Schools); the East African submarine cable project; the associated NEPAD broadband access fibre-optic project for landlocked African countries; the NEPAD capacity building project for e-learning in Africa (based on the Africa Virtual University); and the e-policies and e-strategies project (NEPAD, 2005:1).

The e-School initiative is a project aiming to instill ICT skills in students graduating from both primary and secondary schools in Africa (Evoh, 2007; NEPAD, 2005). In order to achieve this goal, the e-Africa Commission is coordinating strategic partnerships between technology developers in the private sector and the governments of African countries. To participate in this initiative, governments are required to sign a memorandum of understanding (MOU) with the e-Africa Commission. Private sector partners develop and implement ICT infrastructure and human capacity in schools to facilitate the integration of ICT in teaching and learning. The governments, on the other hand, coordinate resource mobilization made possible through budget allocations (Evoh, 2007; Farrell, Isaacs & Trucano, 2007:18).

The e-Schools are equipped with computers interconnected through local area networks (LANs). In turn the individual LANs are linked via satellite to form a wide area network (WAN) that stretches across the continent**.** The Regional African Satellite Communication Organization (RASCOM), with the support of the International Telecommunication Union (ITU), designed, assembled and launched a satellite - RASCOM-QAF 1 - into orbit on the 21st of December 2007 (RASCOM, 2011) to support the e-Africa Commission's activities. Through RASCOM-QAF 1, rural regions in Africa have been able to access affordable telecommunication services and internet connectivity using the Very Small Aperture Terminal (VSAT) (RASCOM, 2011). NEPAD's e-School initiative was designed to tap into the cost benefits of connectivity through this satellite link and to connect schools in Africa regardless of their location within the different national boundaries (NEPAD, 2005).

The NEPAD e-Africa Commission is piloting the NEPAD e-School project in 17 African countries, namely Algeria, Burkina Faso, Cameroon, Democratic Republic of Congo, Egypt, Gabon, Ghana, Kenya, Lesotho, Mali, Mauritius, Mozambique, Nigeria, Rwanda, Senegal, South Africa and Uganda (NEPAD, 2005). The NEPAD e-School initiative is a novel innovation that earned NEPAD the Global Intelligent Community Visionary of the Year 2005 award. The initiative provides a framework for (and a systematic approach to) ICT integration in education on the African continent. The e-School initiative's specific objectives are to: instill ICT skills in students that enable them to participate in the knowledge society upon graduating; enhance teachers' capacities through the use of ICT in teaching; and improve school management and increase access to education (NEPAD, 2008).

1.1.1 Trends in e-Schools' development

The e-Africa Commission did not pioneer the e-School concept. A variety of transformed school systems have evolved in the new millennium to meet the demands of the complex society and work life of the 21st century. Most of these transformed schools make attempts to integrate information and communication technology (ICT) in teaching and learning. The integration entails the combination of printed material, radio, video and face-to-face experiences alongside the use of computers and the internet in enabling people to learn effectively in ways that are appropriate to their needs (Unwin, 2005:117). Learning in such environments where traditional classroom teaching is supported with online delivery and the use of multimedia is referred to as blended learning (Unwin, 2005; Smart & Cappel, 2006; Driscoll, 2002). Various countries have named the transformed schools differently and used different approaches in their implementations. United

Kingdom, for example, introduced 'Scholar', an e-School system maintained by Harriot-Watt University. Scholar aims to're-culturalize' school management in the maintenance of data and adoption of new teaching approaches (Simpson, Payne & Condie, 2005; Condie & Livingston, 2007). Scholar was designed to complement teaching and learning within the schools, but has since extended to e-learning without borders. The main features of Scholar include course materials, revision exercises, self assessment facilities, and discussion forums through a computer system (Condie & Livingstone, 2007). Students engaging with Scholar may access e-resources from designated ICT laboratories and at home through the internet (for those who have this infrastructure at home). The teachers' information system (IS) interface enables them to enter students' records, post tailor-made assignments, and monitor the progress of individual students through an online reporting system (Condie & Livingstone, 2007).

Another example is "Smart Schools", launched in Malaysia in January 1999. Smart Schools apply a wide range of technologies in the teaching and learning of some subjects, including English, Bahasa Melayu, science and mathematics (Ya'Acob, Nor & Azman, 2005). The Smart School project is integrated in the teaching and learning processes and in school governance. It places emphasis on the curriculum, pedagogy, assessment methods, and materials for teaching and learning (Ya'Acob, Nor & Azman, 2005). The initial Smart School project supplied schools with computers which were installed in computer laboratories and connected to the internet. However, the students were not given internet-based e-mail addresses which could facilitate their communication with schools in different locations (Ya'Acob, Nor & Azman, 2005: 23). This omission could be explained by the associated cost of installing and managing e-mail exchange servers for a large student community. E-mail exchange servers require skilled ICT experts to manage them. The Smart Schools did not provide skilled personnel, nor was there provision for training the teachers. According to Ziguras (2000:56), the Smart Schools were provided with a few computers for a large student population, but the hardware stayed idle because no one knew how to use them.

A second version of Smart Schools named "Sekolah Bastari" was later introduced in Malaysia. Sekolah Bastari democratizes the school setting and allows students to move at their own learning pace with the facilitation of teachers who receive special training. The Sekolah Bastari culture does not emphasize ICT use, but liberalizes its deployment and use where the facilities would promote students' aims (EL-Halawany & Huwail, 2008).

A third example of modern schools is the "Star Schools" in South Africa and Namibia. These two countries run a series of special schools modeled in a similar fashion to Sekolah Bastari but branded Star Schools. After several years of experimentation, Star Schools have been re-branded as "Star to Life". Star to Life schools provide registered members with online resources, compact disks, DVDs and coaches (Starschools, 2009). Star to Life schools inspire and motivate high school students to believe in their dreams for the future and encourage health education which includes advocacy materials on AIDS-free lives. Star to Life schools also provide secondary school students with short term online courses and revision exercises.

Of these modern schools, the most common strand the world over is the electronic school (e-School) (UNICT Task Force, 2005), which falls into the framework of Malaysian Smart Schools and the NEPAD e-Schools. These transformed schools have a common ideological framework, which is to encourage lifelong learning amongst students (Ya'Acob, Nor & Azman, 2005; Condie & Livingston, 2007) with a common strategy – the integration of ICT in teaching and learning (EL-Halawany & Huwail, 2008). Lifelong learning refers to continuing with education outside the traditional classroom setting and long after a person exits from formal education at any level. It requires a mastery of collaborative learning and self-directed learning skills, usually promoted through problem-based learning (PBL) (Hmelo-Silver, 2004). Learning is said to be collaborative when a group of learners engage in shared activities that result in the generation of new ideas and therefore learning. A student who practices collaborative learning is believed to be capable of developing teamwork skills. Self directed learning is when a learner seeks content and learning objects on his or her own without the support of an instructor. Self directed learning inculcates in the learner confidence and independence when problem solving. These two characteristics (teamwork and confidence) are critical in modern work life. Condie and Livingston (2007) proclaim that because what we know about the world is constantly changing, these changes require critical thinking that is promoted through the use of ICT in education.

According to Cox and Abbott (2004), confidence when problem solving has been confirmed in students who learn using integrated ICT. However, critical thinking has not been confirmed, and its absence is attributed to the structure and content limitations of the curriculum (Hughes & Daykin, 2002). As Lorenzo and Dziuban (2006:2) observe, the way the younger generation of students engages with internet resources suggests a shallow utilization devoid of analysis and synthesis, which require complex thought processes. The capabilities of information and communication technology are not fully exploited in this shallow utilization of resources (Bennett, Maton & Kervin, and 2008:781). According to Bennett, Maton and Kervin (2008), this new generation of students, also referred to as 'digital natives', have a lot of information around them but do not have the capacity to manage its use for optimal benefits.

If the students are well guided, much more benefits may accrue from blended learning. It takes concerted efforts of teachers coaching individual students through the e-School to achieve these benefits. The teacher may group students according to their abilities and assign them tasks at varied levels and progressively introduce higher competency tasks to those students with lower capabilities. Simultaneously, the teacher would give faster learners higher level tasks and direct them to search for material to help them complete these tasks on their own (self directed learning). Differential coaching can be conducted without the risk of faster learners being held back by slower learners. An expert coach in one school may also work with students in several other schools within the e-network. This would result in higher productivity which has not been achieved in the education sector to date (the education sector has remained the most labour intensive sector in most societies) (Bonk, Wisher & Lee, 2004).

The success of the transformed schools depends on teachers' readiness, students' preparedness to use learning objects, suitability of the information systems (IS) infrastructure, and curriculum design. Teachers' readiness refers to their attitude towards the integration of IS in teaching and learning and their ability to use these new technologies (Hew & Brush, 2007:229). The teachers' readiness may be achieved through training on the use of technology and retraining on pedagogies to adopt new teaching approaches adaptable to the integration of IS in teaching and learning (Hwe & Brush, 2007:244).

Traditional education has the teacher at the center of instruction with knowledge transfer to a passive student (Ya'Acob, Nor & Azman, 2005:20), whereas blended learning is learner-centered with the learner determining the material for learning and the pace of learning. Ya'Acob, Nor and Azman (2005) argue that the integration of ICT in education requires a different pedagogy where teachers change from "sage on stage" to facilitators. Evaluations of the performance of transformed schools indicate that the transition from traditional to blended schooling has not been smooth despite traceable gains (Condie & Livingston, 2007). The benefits of blended learning are observable in improved student performance (Condie & Livingston, 2007) and students' positive attitude towards taking full control of their learning, which makes them resourceful (Ya'Acob, Nor & Azman, 2005). A striking benefit observed in Malaysia was the 50% growth in ICT users within three years (2000 to 2003) of the introduction of the Smart Schools (EL-Halawany & Huwail, 2008). In general, proponents of e-Schools argue that e-Schooling promotes collaborative learning and explorative or engaged learning. As a result, their use leads to the mentoring of critical thinkers capable of problem solving and lifelong learning. These benefits will virtually always outweigh the cost of investment because there is always a pay off (EL-Halawany & Huwail, 2008).

Teachers, however, tend to be nostalgic in this role-swap with students. Only a few teachers are willing to take the role of mentors and facilitators in the classroom. Economies have also not been strong enough to support the ideal infrastructure for the transformation of schools. In most ICT integration initiatives in education, infrastructure is limited and the in-service training of teachers is inadequate. Nevertheless, it would be beneficial if a thorough evaluation

of existing e-Schools in Africa is conducted to inform future investments in e-Schools. In order to evaluate the NEPAD e-School initiative, the next section discusses the progress of its activities against its objectives.

1.1.2 NEPAD's e-School implementation

The NEPAD e-School programme was launched in 2003 in Durban (South Africa), but it was not until 2005 that the first e-School demo was inaugurated in Uganda (Farrell, 2006; NEPAD, 2005). Inaugurating e-Schools in individual countries required a needs analysis report from each country (NEPAD, 2008). Countries which have signed the MOU to participate in phase one of NEPAD's e-School initiative were required to establish at least six e-Schools to inform the full scale roll-out of the project across the continent. The pilot phase of the e-Schools is at different stages of implementation in participating countries. For example, in Kenya, Mauritius, Rwanda and Uganda, the six e-Schools had been established by the year 2005 (Farrel, 2006), while Algeria and Nigeria only completed the required e-Schools in 2009 (NEPAD, 2011).

Part of the predicament of the e-Africa Commission, as revealed in the interim evaluation report (Farrell, 2006), is the tendency to stretch the objectives of the demo e-Schools beyond the original objectives of NEPAD. The e-Africa Commission has included identifying best practices for management of programme partnership arrangements as an additional objective of the pilot e-School projects. This was never anticipated in the NEPAD e-School project. Secondly, leadership in coordinating the e-School initiative has also been lacking. Apart from understaffing in the e-Africa Commission, as observed by Farrell (2006), project management of the e-Schools has not been steady with the resignation of the project manager to join one of the consortium partners. The e-Africa Commission accepts that it took up a task it was ill prepared for (Ferrell, 2006).

Apart from leadership issues, the e-School initiative is one of a kind in the world in terms of scale. The resource requirements, from human resources to technological and financial resources, were estimated at USD 240 billion (NEPAD, 2008). However, according to Farrell (2006), one consortium estimated the cost of setting up a single e-School demonstration at USD 4.8 million - ten folds more than the original continental estimate. If the consortia members, consisting of ten institutions, were to equally share the cost, each partner would be expected to raise USD 500,000, meaning serious budgeting concerns for all involved. This may account for the delay in the initiation of the pilot projects in some countries.

Other causes of delay are tied to infrastructure. The consortia members were tasked with supplying and installing equipment and networks, but without the requisite budget for construction or buildings. The equipment therefore had to be installed in existing buildings except where the hosting school was willing and able to put up a new building. Some schools did not have empty buildings and therefore the installation of equipment had to be delayed as alternative housing was organized.

Lastly, even within the countries with 100% implementation, negotiations between governments and private partners on the cost of the project took most of the 12 months that were allocated to the demonstration phase (Ferrell, 2006).

1.1.3 Limitations in the evaluation of e-Schools

In its original patent, the e-School teaching system consists of four sub-systems: students' sub-system, teachers' sub-system, library sub-system and administrative sub-system (Nobles et al., 1989). The sub-systems are software modules that facilitate access to databases and communication. In this configuration, students, teachers and administrators can locally access digital material and also access remote (national and global) resources through the communication sub-system.

The present model of e-School has communication as a major sub-system that facilitates collaboration between dispersed teachers and students and data communication between the administrative sub-system and the Ministry of Education. They are designed such that students could access digital content for the national curriculum, teaching materials deposited by their teachers, and asynchronous lessons conducted centrally by a service provider The students should also communicate with their peers in other e-Schools to form collaborating teams. Teachers are expected to develop and conduct lessons, and video record lesson sessions. The video-recorded lessons are documented in the computer laboratory where students can review them. Through collaborative efforts, recorded lessons may be shared between schools.

Teachers have the opportunity to record students' daily class attendance using the e-School and enter students' performances in the assessment modules. This allows the administration to view the students' data and share this with the Ministry of Education. Parents are also expected to benefit because they can view their children's reports on the internet.

NEPAD e-School shares these characteristics. It has distinct sub-fields within the main project. These sub-fields are identified as dimensions. The success of the NEPAD e-School is the pooled success of all the dimensions. A suitable evaluation approach should therefore have the capacity to evaluate the individual dimensions and the project in its entirety. Generally projects have an inbuilt evaluation framework. The NEPAD e-School as a project has an inbuilt context, input, process and product (CIPP) evaluation model (Farrell, 2006). CIPP is one of the older and better tested models of programme evaluation (Stufflebeam, 2002). The model has been successfully used to evaluate e-learning (see for example Ravai, 2003; Kromrey & Hilbelink, 2005). The interim evaluation report on NEPAD's pilot e-Schools in Africa, undertaken by Commonwealth of Learning (COL), used the CIPP model to evaluate the NEPAD e-Schools as a programme in six countries including Kenya. The model is rigorous for monitoring and evaluation purposes, but as pointed out by Farrell (2006), falls short of the rigor of analysis domicile in empirical approaches best applied by the academic community. Its uses have been limited to evaluating programmes, and little is known of its effectiveness in evaluating systems.

A distinction is made between a programme or project and a system. Whereas a project is considered to be one entity that experiences homogeneous context and input, a system consists of sub-systems whose contexts and inputs may vary depending on the specific process one focuses on. The Commonwealth of Learning considered the e-School to be a project and conducted its evaluation to ascertain accountability in order to achieve the desired output – a working e-School. This approach considered only one aspect and left out the other aspects of the system. The CIPP model may therefore not bring out how the different dimensions of the e-School interact and impact on the entire system and the project. This study applied DeLone and McLean's (D&M's) IS Success Model to evaluate the NEPAD e-Schools because it disintegrates a system into sub-systems (the dimensions) and evaluates each dimension first as stand-alone entities and secondly as they interact within the whole system.

1.1.4 Contextual Setting: e-Schools in Kenya

The Kenyan government has made courageous and commendable strides since 2003 in striving for Education for All (EFA). Free primary education was introduced in the year 2003 (Ngware, Onsomu & Muthaka, 2007), and semi-free secondary education was introduced in 2008. The country's education system does, however, face a number of problems. For example, while the enrolment level in primary schools improved to 100% in 2004, the retention was low and transition rate from primary to secondary schools was equally low at 50% in the year 2009 when the first 'graduates' of free primary education were admitted in secondary schools (World Bank, 2009). The student-teacher ratio also remained low. Some of these issues may be addressed in a well integrated e-School as envisioned by the NEPAD e-Africa Commission.

The NEPAD e-Africa Commission envisages that in the long-run, modern communication technologies are expected to be widely deployed for teaching and learning in primary and secondary schools across Africa (Evoh, 2007). At present, six secondary schools (Chevakali High School, Isiolo Girls Secondary School, Maranda High School, Menengai Secondary School, Mumbi Girls Secondary School and Wajir Girls Secondary School) are trialing NEPAD e-Schools in Kenya (Farrell, 2006). The e-Schools are distributed in six provinces as shown in figure 4.1 in chapter 4. The schools were supplied with computers, printers, scanners, local area networks, Digital Satellite TV, Smart Boards and VSAT equipment for internet access. This equipment was then installed in computer laboratories that had been created for the purpose. The schools were required to build large computer laboratories in order to enable the programme to expand where necessary. Two teachers from each school were trained in ICT proficiency, maintenance and the integration of ICTs in teaching and learning. In turn, the trained teachers were required to train other teachers and induct learners (NEPAD Kenya, nd).

The NEPAD e-Schools in Kenya have therefore received the necessary infrastructure and human capital for the integration of ICT in teaching, learning and school governance. The pilot has been in place long enough for its impact to be felt based on the objectives of the NEPAD e-School initiative.

1.2 Research problem

The main research problem was to determine the level of success of the pilot phase of the NEPAD e-Schools in Kenya based on the following:

1. NEPAD (2004) estimated that by the end of 2008, each youth graduating from an African high school would be ICT-literate, and by the end of 2013, each child graduating from an African primary school would be ICT-literate arising from the implementation of the e-School initiative. This projection was made at the launch of the pilot phase in 2003. Project piloting was to last only one year to give way to full scale implementation, which is now behind schedule by several years. It is not clear whether the delay has been caused by delays in infrastructure installation or sorting out the challenges exposed through the pilots. In order for the pilots to inform the full project, the right infrastructure needs to be installed and tested. This study undertook to determine the quality of the ICT infrastructure installed in NEPAD e-Schools and determine the infrastructure's ability to provide the students with the ICT skills envisaged in the project's objectives.
2. Farrell (2006) reported in the initial interim report of NEPAD's pilot e-Schools' evaluation that the project had encountered serious challenges, some arising from the e-Africa Commission's failure to meet its leadership responsibilities. Soon after the launch of the pilots, the NEPAD e-Africa Commission left all its activities to the consortia (Microsoft and Oracle). This ceding of leadership may have resulted in variations in the interpretation of the mission of the project. The study therefore sought to establish whether the mission of the pilots on the ground is consistent with the mission spelt out by the NEPAD e-Africa Commission and the extent to which this mission was succeeding. One of the critical benchmarks in the mission was to empower teachers with ICT skills. The trained teachers would in turn train their colleagues in a cascading model and also induct students in the use of these systems. Since the e-Africa Commission ceded leadership to consortia members, there is uncertainty as to the quality and relevance of the training the teachers and students receive. This study therefore set out to establish the effectiveness of the training imparted on teachers and students.

3. Evoh (2007) rightly pointed out that the goals of the NEPAD e-School initiative are idealistic. The NEPAD e-Africa Commission expanded the aims of the e-School beyond what was initially envisaged. Broadening the aim of the project could potentially relegate key objectives, such as the integration of ICT in teaching and learning, further down the line. It is not clear whether infrastructure utilization is aligned to the integration of ICT into teaching and learning. According to O'Neil (2002), "While many people who have experience in the use of ICTs see at least some potentials of their use in improving some aspects of the society, little objective research exists that can back up these claims." Furthermore, the cost of the implementation of e-Schools is very high. Such costs should be incurred only when the benefits of the programme justify the investment. This study therefore set out to establish the extent to which e-School infrastructure is being used to integrate ICT in teaching and learning, the users' level of satisfaction with the e-Schools, and the benefits accruing from the implementation of e-Schools.

The current study empirically evaluated the e-School demo in Kenya and focused more attention on the original NEPAD e-School objectives to establish the level to which the project was succeeding. This approach is believed to be more focused, detailed and academic-oriented than the monitoring and evaluations hitherto undertaken by COL, thereby adding value to the monitoring and evaluation (M&E) inbuilt in the pilot phase of the NEPAD e-School initiative. The outcome of this study would inform the e-Africa Commission on the suitability of infrastructure; content and communication quality; training effectiveness for the NEPAD e-School vision; relevance of the use of the infrastructure to ICT integration in learning; the users' satisfaction with the infrastructure; and the benefits of the project from the perspective of students and teachers. The outcome of the study would be useful to those looking for expert opinion on e-School systems (NEPAD, 2008). Theoretically, the study contributes to discussions and debates surrounding IS success evaluations.

1.3 Study's objectives

The overarching aim of the study was to undertake an empirical evaluation of the success of NEPAD's pilot e-Schools in Kenya. The specific objectives were:

1. To establish the ICT infrastructure installed in the NEPAD e-Schools and determine the infrastructure's quality, accessibility and suitability for enhancing teaching and learning;
2. To determine the effectiveness of the training imparted on teachers and students to enable them to constructively engage with the installed ICT infrastructure in teaching and learning;
3. To establish the extent to which e-School infrastructure is being used to enhance teaching and learning and provide health information;
4. To determine the extent to which e-School users (students and teachers) believe the e-Schools prepare students to function in the global economy; and
5. To establish the extent to which the e-School improves the efficiency of school management and the processes of teaching and learning.

1.4 Research questions

In order to investigate the above objectives, the study was guided by the following seven research questions:

1. What is the quality of the ICT infrastructure installed in e-Schools and how is it accessible and suitable for enhancing teaching and learning?
2. What is the effectiveness of the training imparted on teachers and students in facilitating constructive engagement with the installed ICT infrastructure in teaching and learning?
3. To what extent is the e-School's infrastructure being used to enhance teaching and learning?
4. Is the e-School enhancing health literacy among teachers and students?
5. What is the perception of the e-School users on the e-School's ability to prepare students to function in the global economy?
6. How well is the e-School improving the processes of teaching and learning?
7. Is the e-School improving efficiency in the management of the schools?

1.5 Study's hypotheses

In undertaking the study, seven hypotheses were derived and tested to facilitate the confirmation or disconfirmation of the success of the pilot e-Schools in Kenya. This section derives the hypotheses and discusses how the testing was conducted.

1.5.1 Installed ICT infrastructure for enhancing teaching and learning

IS infrastructure is very broad and includes the building/laboratory that houses core equipment, computer workstations and peripherals, operating systems, installed user applications, networking architecture, and accessories (Tong, 2004:4). The building that houses core equipment has to meet certain specifications, such as space and air circulation. For example, the temperature of a server room is controlled to dissipate the heat generated by the system. Workstation specifications, such as processor speed, screen size and ergonomics of peripherals, suit different users. The access and navigation of a user application tend to facilitate the comfort of users. During communication, the network speed will determine how easy it is to download or upload documents and information in general. These aspects of the quality of the e-School determine whether the system is acceptable to users and consequently whether the system is suitable to use. In order to determine the quality of the e-School and its success, the study tested the following hypothesis.

H_1: The quality of the installed e-School infrastructure (the IS) determines the level of success of the e-School initiative.

E-School users often need support in unexpected situations that arise while they are using a system. These unexpected situations may arise from system overload, bugs, or simply malfunctions in the system. Other users may simply seek help having forgotten a procedure while operating the system. IS personnel are there to help in such situations. A speedy resolution and the manner in which the resolution is made (politeness and effectiveness) will determine the user's success with the IS. In order to determine the service quality of technical personnel and their contribution to the success of the e-School, the study tested hypothesis 2, i.e.:

H_2: The high service quality offered by technical personnel contributes to the success of the e-School system.

Information is largely understood as processed data (Mingers, 1995) or a representation of some artifact. Information may be presented in the form of text (combination of words), graphs, pictures, etc. With respect to IS, information quality refers to the ease of access to the information, visibility, readability, interpretability and relevance. Ease of access is especially relevant in the case of a repository. Information objects in a repository should have unique addresses that are easy to remember when asking the system to retrieve the information object. The readability of the information object refers both to the visibility of the text, and navigation through the volume. A repository may hold a large volume of information. With respect to the reader, the overarching quality of the information is its relevance to the subject area or the flow of the presentation such that a user who is accessing the information object for the first time readily appreciates the communication. With respect to the e-School, the quality of information refers to the relevance of the content to the curriculum and the ease of navigation through the volume of information. To determine the quality of information content and its relevance to the curriculum, the study tested hypothesis number three which states that:

H_3: The quality of information content and communication contributes to the level of success of the e-School initiative.

1.5.2 Effectiveness of the training imparted on teachers and learners

Showing users how to operate the information system offers a chance to expose the users to the system. While training, a user begins to form an impression of the IS and grows more confident as he/she repeats tasks and uses the system. Effective training swings the impression of users who may be holding ambivalent attitudes towards the system to a positive impression. The training method, approach and its length at times impact on the effectiveness of training. Specific to ICT user training, it is incumbent upon the trainer to apply approaches that increase computer self-efficacy among the trainees. Most users of the e-School system are new to IS and therefore training may makes a major contribution in motivating them to use the system. In order to establish the effectiveness of the training and its contribution to the e-School success, the study tested the 4th hypothesis that states:

H_4: Effective training methods and approaches contribute to the success of the e-School system.

1.5.3 E-School use

E-School system use is the application of the system in attaining the goals of learning. This requires the integration of the system in teaching and learning by both the teachers and students. The system is expected to facilitate teachers in the classroom delivery of the curriculum and assisting students as they do private studies. It enables students to review lessons that they did not understand or a subject taught by an expert teacher in another e-School. The system exposes students to study materials that enable them to attain advanced perspectives on the subject matter. When students communicate with their peers in other e-Schools, they also develop teamwork skills. The e-School system has rich and relevant material that is accessible at any time from any location. The accessible materials are not limited to the curriculum, but also include health information. E-Schools therefore improve the learning process and enhance health literacy. Use of the e-School system therefore improves teaching, learning and health literacy. In order to establish the nature of e-School use and its contribution to the success of the e-School, the study tested the 5th hypothesis, namely:

H_5: The extensive and exploitative use of the e-School system contributes towards the success of the e-School system.

1.5.4 E-School user satisfaction

Users of a system form opinions as they interact with the system. These opinions are normally evaluative and broadly cover all aspects of the system. The attitudes of the users towards the system are informed by their perceptions of system quality, information quality, training (advocacy) and use. A user who appreciates most of the aspects of the IS will have a favourable attitude. For example, a teacher who received effective training will find it comfortable using the e-School system and is likely to raise fewer complaints, which suggests a higher level of satisfaction. On the other hand, a student who has very limited access to the e-School system will feel deprived of the opportunity to effectively use the system and therefore develop an unfavourable attitude towards the e-School. A high quality system and information (content) that is easy to use as a result of effective training is satisfying to users. This led to the sixth hypothesis of the study:

H_6: The high level of satisfaction of teachers and students with the e-School system (all aspects, including system quality, content and communication quality, use, and exploitation and training) contributes to the success of the e-School system.

1.5.5 E-School net benefits

An information system is normally implemented with the overall goal of improving organizations' strategies for future gains. In an industry, an organization may drag its feet due to inappropriate strategies that deny it opportunities for future benefit streams. The implementation of an appropriate information system may assist with the re-engineering of operations to cut down on costs or help improve in the management of stakeholders, thereby increasing satisfaction among the stakeholders. This satisfaction is normally reflected in the level of market value appreciation. Specific to e-Schools, the implementation of the e-School system may enhance efficiency in the use of resources, effective delivery of the curriculum, and collaboration amongst teachers with the result of exchange of useful tacit and explicit knowledge. The effects of knowledge sharing between collaborating schools may result in the improvement of the performance index of the school. Parents and the public may reflect on this when making the schools a first choice for their children. This would be a source of more entrenched satisfaction within the school community, giving credence to more intense use and therefore more benefits. This therefore led to the seventh hypothesis of the study:

H_7: The net benefits of IS contribute to the success of the e-School system.

1.6 Significance of the study

The current study highlights the level of success of the pilot e-Schools and specifically indicates areas that need urgent attention before the full scale e-School initiative is rolled out. Issues of the e-School system are addressed from seven distinct perspectives (infrastructure, content, service, training, use, user satisfaction and net benefits) which should make it easier for the e-Africa Commission and its consortia to identify problem areas and take corrective measures. The study also informs the e-Africa Commission on the suitability of the e-School components for the realization of the overall goals of the initiative. In investigating the net-benefits of the e-School, the study highlights areas that should be exploited in achieving returns to the investment in e-Schools. In particular, the study makes an attempt to correlate students' performance to the implementation of the e-School. The outcome will therefore provide information on how to exploit the potentials of ICT integration in teaching and learning to change trends in students' performance.

To the academic community, Ward and Taylor (1996) posit that there is very little work on information systems' evaluation. Furthermore, evaluations in extant literature tend to delineate only certain components of an IS for study. The current study has considered all e-School components and subjected them to evaluation. DeLone et al. (2008) point out that very few IS evaluation studies have used validated success evaluation instruments for the different success dimensions, making it difficult to compare the results of different evaluations. The current study used mainly validated evaluation instruments, which therefore contributes to the accumulation of knowledge of the effectiveness of these instruments and promotes the comparability of results. The study is therefore valuable in contributing to knowledge generation for IS evaluation based on DeLone and McLean's (2003) evaluation framework.

1.7 Limitations of the study

The study was limited to the evaluation of the e-School system from the perspectives of students and teachers and observations made by the researcher on a single day of visit. However, there were some issues, such as use of the system, which could have been measured through observations longitudinally. Longitudinal measurement of the use of a system tends to be more accurate than reported use. Respondents tend to exaggerate reported use solely to make them appear pleasant to the investigator. These exaggerations may be minimized by corroborating the responses with systematic observation that documents actual use. Other means of corroborating information could be achieved through clarification from both partnership members (consortia) and the e-Africa Commission, but the study could not incorporate this in the design as it would have increased the cost and period of data collection.

In evaluating the net-benefits dimension, the study could have benefited from interviews with students who had graduated from the e-Schools and the organizations that had taken the students either as learners or employees. This could have extended the scope of the study but would have required more time and resources. Tracer studies could be considered in follow up studies.

1.8 Definition of terms

Blended Learning: This refers to learning activities which combine traditional teaching with the use of modern information and communication technologies.

Content: This refers to a variety of learning materials which form part of the repository of an e-School, such as text or multimedia.

E-learning: The use of networks and information and communication technologies (ICTs) to deliver education and training (Welsh, Simmering & Brown, 2003).

E-School: This refers to a traditional school which has installed ICT for integration in curriculum delivery and management.

ICT Champion: This refers to a teacher who has received technical and advocacy ICT training and is tasked with inducting other teachers and students and using advocacy to popularize ICT adoption.

Information System: This refers to a combination of people in an organization, procedures, software and hardware, that is used to gather, analyze, store and retrieve digital information (Sue, Nicola, Christopher, Ben, 1999).

Information system success: This refers to the achievements of the information system based on performance characteristics such as resource utilization, hardware utilization, efficiency, reliability, response time, ease of use, etc (DeLone and Mclean, 1992).

Information Quality: This refers to the degree to which the information can be perceived and accessed (Wei Hu, 2003).

Net Benefits: This refers to accruad **impacts of** information systems on users, other stakeholders, the society and the organization.

Life-long Education: This refers to education and training achieved outside the formal school environment.

Self-directed learning: This refers to the learning process in which the learner decides on the objectives and learning object without the influence of an instructor.

System Quality: This refers to a judgment of the degree to which the technical components (including hardware, software, and peripherals) of delivered IS provide the quality of information and service as required by users.

Service Quality: This refers to the measure of the overall support provided to the user by the technical personnel.

Training Effectiveness: This refers to the achievement of the objective of training in influencing trainees' attitudes and imparting desired skills.

User Satisfaction: This refers to the degree to which users are happy or unhappy about the overall use of the system.

1.9 Summary

This chapter introduced the New Partnership for African Development's (NEPAD's) e-School initiative and literature on trends in electronic schools in other parts of the world in order to identify common and best practices. This was followed by a critique of the limitations in the application of information and communication technology (ICT) in modern schools for teaching, learning and management, and a detailed overview of the progress of NEPAD's e-Schools. Next was a brief summary of how this thesis evaluated the success of NEPAD's pilot e-Schools in Kenya, with the evaluation underpinned by NEPAD's objectives.

CHAPTER TWO

THEORETICAL FRAMEWORK

2.1 Introduction

The diffusion and integration of information and communication technologies (ICT) in educational institutions, specifically secondary and primary schools, gained momentum in the late 20th century and has continued to attract large investment (Blignaut, Els & Howie, 2010: 558; Ng & Gunstone, 2003). Secondary and primary school education has the largest population of learners. Therefore any attempt to supply ICT infrastructure with a high computer to learner ratio will require a high capital outlay. As with any other investment, an electronic school system needs to be evaluated in order to establish whether the investment would be valuable to the school community and/or to identify where improvements to the system or investment can be made. Proponents of the e-School system argue that ICT integration in curricula could potentially increase productivity in schools (Draca, Sadun & Van Reenen, 2006) and impart teamwork skills and lifelong learning habits among learners (Ya'Acob, Nor & Azman, 2005; Condie & Livingston, 2007). These arguments are the tenets that have propelled the rapid diffusion of ICT in schools in many countries. The extent to which these envisaged benefits of e-Schools can be achieved can only be determined through systematic evaluation.

The electronic school (e-School) has several components: technology, information processing, personnel and other semiotics. Although there is no universally accepted definition of IS (see for example Alter, 2008:1), the most commonly mentioned components (data, computers, technology, software, personnel and society, as identified by Paul, 2007; Lyytinen & Newman, 2006; and O'Brien, 2003) are recognizable in the e-School. Digitized content is stored in computers in the e-School for retrieval and use by students and teachers while computer networks facilitate communication between, (i) Students and students, (ii) Students and teachers, (iii) Teachers and teachers, and (iv) Students and teachers on the one hand and society on the other. The e-School therefore meets at least the basic requirements that qualify it as an information system. Although the evaluation of an information system is part of the system development cycle, many IS researchers before 1992 (DeLone and McLean, 1992; Mahmood & Medewitz, 1985) conducted only partial evaluations. Such evaluations measured various components of IS success but never defined dependent variables in their investigations (DeLone & McLean, 1992). In a synthesis of past studies, DeLone and McLean (1992) identified the existence of at least six dimensions which constitute independent variables, with IS success as the dependent variable that led to their conclusion that evaluating the success of any information system requires measuring the performance of each and every dimension of their proposed IS Success Model.

Many studies have applied D&M's IS Success Model while evaluating a variety of information systems in different settings, e.g. the e-commerce system (Chang, Torkzadeh & Dhillon, 2004; Molla & Licker, 2001), the knowledge management system (Ong & Lai, 2004), and the educational course content management system (Adeyinka, 2009), among others. There is, however, no known study that has used D&M's IS Success Model to evaluate an e-School system. The efficacy of D&M's IS Success Model in the evaluation of an e-School system is therefore not known. This study adapted and used D&M's IS model to evaluate the success of the pilot phase of the New Partnership for Africa's Development's (NEPAD) e-School initiative.

2.2 D&M's IS Success Model and subsequent augmentations

In the early 1980s, information system researchers who evaluated the performances of IS measured various independent variables, such as extent of use (Mahmood & Medewitz, 1985) and organizational effectiveness (Milliman & Hartwick, 1987), without defining any dependent variable (DeLone & McLean, 1992). This approach resulted in speculations without predictions and made it impossible to replicate such studies. DeLone and McLean reviewed 180 journal articles published between 1981 and 1987 and synthesized the information to consolidate a coherent body of knowledge. DeLone and McLean (1992) proceeded to argue that the success of an information system is characterized by the quality of its infrastructure, its product and influence (or absence thereof) on users, and the impact it has on organizations (DeLone & McLean, 1992:63). These components constitute the dimensions of IS success. The variety of the dimensions helps demonstrate the many different measures of IS success in literature in the period before 1990 (DeLone & McLean, 1992:62). Different researchers focused their attention on different measures of success. The synthesis of all this literature into a coherent definition of the IS Success Model (see Figure 2.1) was a significant contribution to IS studies. D&M's IS Success Model has received approval, but not without a few necessary extensions and augmentations. DeLone and McLean (1992:83), in their search for the dependent variable, were clear that "it is unlikely that any single, overarching measure of IS success will emerge", which explains the augmentations. In the original D&M IS Success Model, six success dimensions were identified: system quality, information quality, use, user satisfaction, individual impact, and organizational impact.

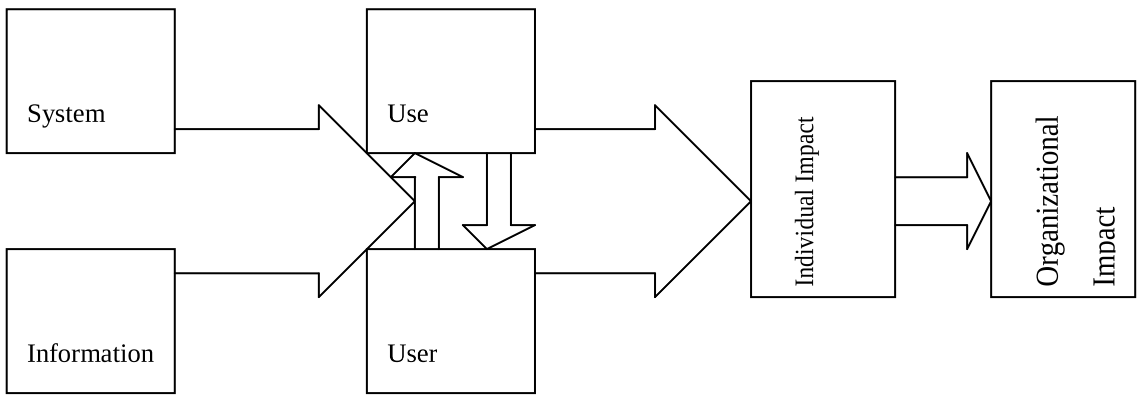

Figure 2.1: DeLone and McLean's IS Model (DeLone and McLean, 1992)

DeLone and McLean's (1992) (or D&M's) IS Success Model has inspired rigorous studies by various researchers. There is a wealth of literature on D&M model validation (ICIS, 2007; Wu & Wang, 2006; Bokhari, 2005; Seddon & Kiew, 1994; DeLone, 1998; Roldan & Leal, 2003) and augmentation (Pitt, Watson & Kavan, 1995; DeLone & McLean, 2003; Adeyinka, 2009; DeLone & McLean, 2008). Seddon and Kiew (1994) examined the relationship between four constructs in D&M's IS Success Model, namely system quality, information quality, system usefulness and user satisfaction. Through path analysis, they established that system quality, information quality and usefulness all contribute to user satisfaction (Seddon & Kiew, 1994:100). In an empirical study that focused on the construct relationship in the knowledge management system, Wu and Wang (2006:737) established the positive and significant influence of system quality and information quality on user satisfaction, and system quality, information quality and perceived benefits on user satisfaction, but no significant influence of system quality on the individual impact dimension defined by DeLone and McLean (1992). This is in contrast to earlier studies by Gelderman (1998) and Teo and Wong (1998). Teo and Wong (1998) studied the performance impact of computerization in the retail industry in Singapore and found that information quality was positively related to managerial satisfaction.

In order to understand the augmentations made to the D&M success model, beginning with the works of Pitt, Watson and Kavan (1995), a better understanding of an information system is necessary. Traditionally, information has been seen as processed data (Mingers, 1995), but it has since been described as data with meaning (Currie & Galliers, 1999). Information is therefore what you get when human beings attribute or attach meaning to data in a particular way (Holwell, 1989; Aiba, 1993 quoted in Currie & Galliers, 1999). On the other hand: “A system is an abstract concept of a complex whole entity of a particular type” (Currie & Galliers, 1999:46). A system consists of sub-systems that are capable of existing on their own and is therefore the layered concept of systems (Mingers, 1995). This means that an information system is a system that attributes meaning to selected data (i.e. of interest to an individual) by processing the data (usually by means of IT) in a way that makes it meaningful to users of the system (Currie & Galliers, 1999). An information system consists of hardware, software, communications’ networks and service personnel. Each of these is also a sub-system component. The whole system performs complex data processing tasks and communicates the resulting information to users through automation or intervention created and designed by various information professionals (such as programmers, data analysts, and many others.). This means that the system is all about service provision. The quality of service users receive enables them to operate more effectively, justifying Pitt, Watson and Kavan’s (1995) inclusion of service quality as a dimension to an augmented D&M IS Success Model.

The augmented D&M IS Success Model which incorporates service quality is shown in Figure 2.2. In this model, system quality, information quality and service quality all contribute to the use of the system and user satisfaction. In turn, use of the system and user satisfaction influence individual and organizational impact.

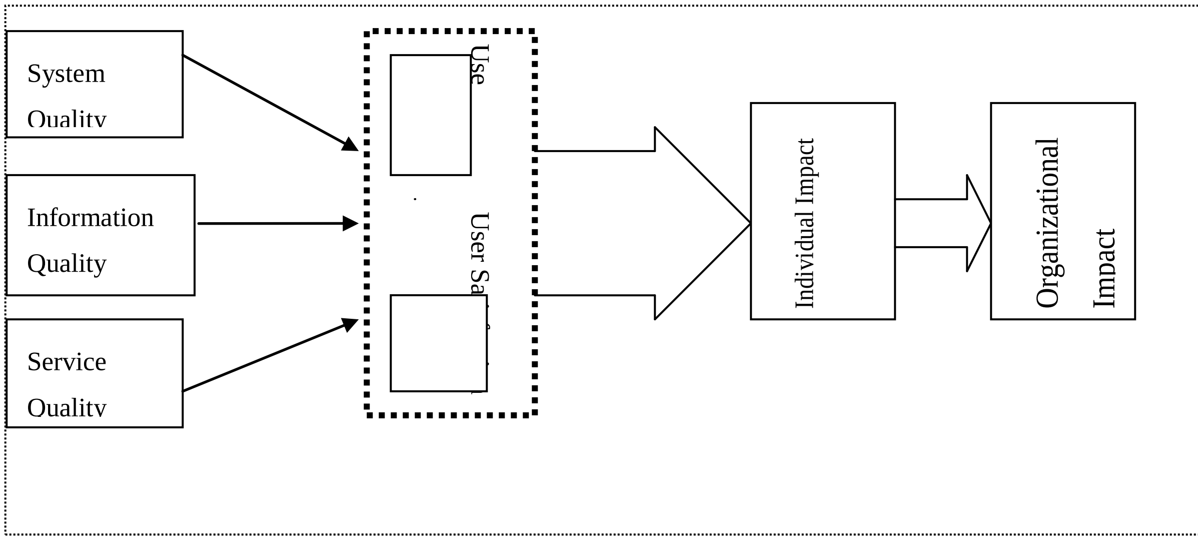

Figure 2.2: Adapted from Pitt, Watson & Kavan (1995)

Seddon (1997:244) argued that D&M’s IS Success Model was confusing because it combined the process model of IS success, variance model of IS success, and variance model of IS as a behavior. He consequently augmented the model by introducing more details at the impact end of the model which he labeled ‘net benefits’. His re-specified model dwelt more on causal effects and invalidated Pitt, Watson & Kavan’s (1995) service quality component which he claimed did not qualify as an application of IT and bore no connection to system quality and information quality. In this argument, Seddon (1997) failed to consider the fact that information systems provide automated services that are pre-set by the IT department. These constitute service provision in the IS Success Model. Seddon’s (1997:246) definition of system quality “as being concerned with whether or not there are ‘bugs’ in the system, the consistency of the user interface, ease of use, quality of documentation, and sometimes, quality of maintainability of the programme code”, describes functions of the IT department and closely links system quality to service quality. DeLone and McLean (2003) recognized the augmentation by Seddon but rejected his invalidation of Pitt, Watson and Kevan’s (1995) ‘service quality’, resulting in a re-specified model as shown in Figure 2.3 on which the current study is based.

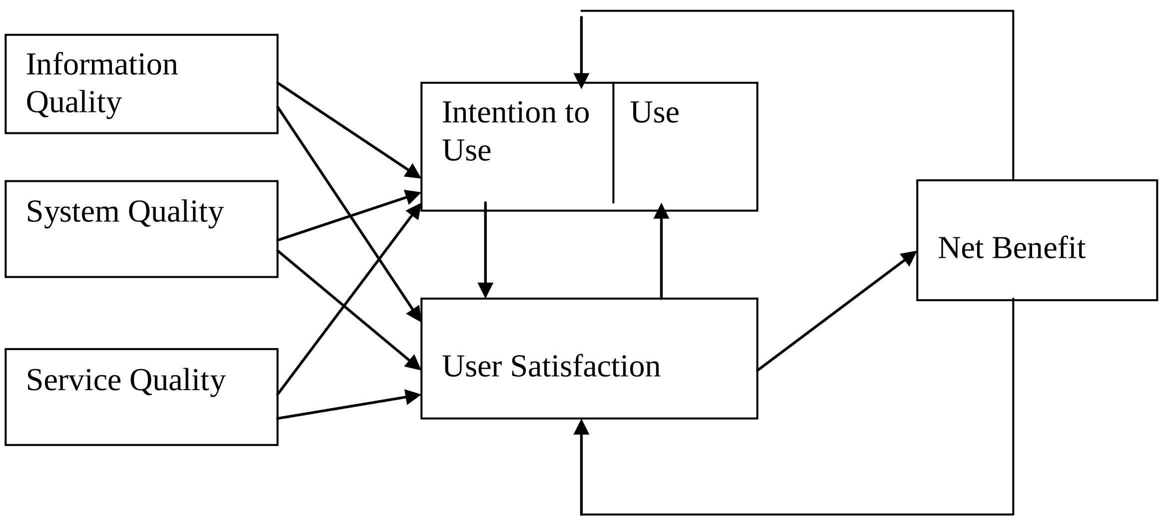

Figure 2.3: Source: DeLone and McLean (2003)

2.3 Adaptation of D&M's (2003) IS Success Model to e-School success evaluation

This section contextualizes relevant dimensions of D&M's (2003) IS Success Model in evaluating the e-School and identifies alternative dimensions whose measurements should make e-School success evaluation more comprehensive. In particular, the 'service quality' and 'net benefit' dimensions of D&M's (2003) IS model are reviewed, with a discussion of how their measurements fit in e-School success evaluation. The training of e-School users and its influence on the success of the e-School is justified as a new dimension that makes D&M's (2003) IS Success Model more rigorous in e-School success evaluation. In addition, the section justifies the need to drop the 'intention to use' dimension in the adapted model of D&M's (2003) IS success.

2.3.1 Service quality

As schools integrate e-resources into their curricula, teachers require reliable systems that facilitate the effective delivery of lessons, provide learners with access to learning objects, and allow teachers to provide customized attention to needy learners (both slow learners and high achievers). The teachers find themselves in challenging environments. The classrooms are overcrowded and in-service training of teachers is not adequate to help overcome this challenge (Yildirim, 2007). To improve classroom delivery using ICT, the e-School system requires IT personnel to provide support to the teachers (Ayere, Odera & Agak, 2010) and ensure that the necessary maintenance and training take place (Pitt, Watson & Kavan, 1995). This ensures continuous engagement between teachers and students and students' un-interrupted access to e-resources. Service provision by IT personnel is therefore paramount to the success of the e-School system. An E-School Success Model that incorporates the 'service quality' dimension, as advanced by Pitt, Watson & Kavan (1995) and supported by DeLone and McLean (2003), may provide useful information about the systems users access and the support users get from IT personnel in order to facilitate uninterrupted use.

2.3.2 Training effectiveness

Many augmented versions of D&M's IS Success Model have retained the 'intention to use' dimension (see for example Pitt, Watson & Kavan, 1995; and DeLone & McLean; 2003, 2008). 'Intention to use' is perceived to arise from cognitive appraisal of past experience (in this case experience with the IS) [Bhattacherjee, 2001] or ease of use or the perceived usefulness of the system (Legris, Ingham & Collerette, 2003). According to Legris, Ingham and Collerette (2003), ease of use and perceived usefulness are the major drivers behind IS use. Ease of use in particular is attributed to the structure of the IS human interface and the technical skills' requirements on the part of the user. Users attain ICT technical skills from exposure and training (Schibeci, MacCallum, Cumming-Potvin, Durrant, Kissane & Miller, 2008). Training effectiveness on use of an information system is therefore a good predictor of IS success. From this perspective, training effectiveness is closely linked to the intention to use dimension in D&M's (2003) IS Success Model. The intention to use a system influences user satisfaction with the system and user satisfaction may in turn re-ignite the intention to use the system. If this two way causality has credence, then we may infer that the "intention to use a system creates user satisfaction and user satisfaction excites one's intention to use". The position of intention to use may, to some extent, be viewed as an antecedent to user satisfaction.

Literature on user satisfaction reveals that one of the antecedents to user satisfaction is attitude or perception, and attitude is shaped through advocacy or training. In this study, training is therefore considered to be an antecedent to both user satisfaction and use. The ‘intention to use’ dimension in DeLone and McLean (2003) model is therefore replaced with ‘training effectiveness’ in the current study. Thus the above inference, when re-written by replacing ‘intention to use’ with ‘training effectiveness’, reads “effective training to use a system creates user satisfaction and user satisfaction excites one for additional training”. Upon exposure to some level of training in any given system, one tends to seek further training in order to obtain an even higher level of proficiency and computer self efficacy.

NEPAD’s pilot e-Schools have been introduced in school environments where most stakeholders had no prior ICT skills. Most of the e-Schools are located in rural areas where ICT literacy tends to be low. Past studies (see for example Fong, 2009) have established a close correlation between income growth and access to ICTs such as the telephone, personal computer, internet and mobile phone. Consequently a large proportion of new students admitted to the e-Schools every year are incapable of using the e-School system. The e-Schools therefore have to conduct training (either computer-mediated or facilitated) regularly to impart skills on new users for the e-School system to succeed.

2.3.3 Net benefits

At organizational level, system benefits range from improved productivity (OECD, 2003) to user innovativeness (DeLone & McLean, 2003), better supplier management, and expanded market-share based on enhanced competitive advantage. As the organization bags these gains, managers’ expectations increase and they invariably recommend system modifications that improve overall delivery. Calls for modification come from user quarters too as users’ expectations grow. In some cases, the users’ innovativeness - creating and trying out new ideas in their work (DeLone & McLean, 2003:20) - result in new innovations that are passed on to the IT department for exploration and subsequent adoption. This study proposes that ‘net benefits’ and ‘user innovativeness’ influence system quality in the direction shown in Figure 2.4.

User innovativeness when using information systems is quite pertinent in the e-School environment, particularly because of the novelty of e-School applications and the need to integrate these applications into the curriculum using suitable pedagogies. The act of innovation in an organization may start at user level and is based on the absorptive capacity of the individual users (Deng, Doll & Cao, 2008). A stream of innovations communicated within the user-network is often required to infuse improvement in the system (Hippel, 2002), which may suggest that innovation drives the improvement of IS quality. Open Source (OS) software is living proof of the success of a user-innovation network. Users of Open Source software innovate and freely reveal their innovations to members of the network who integrate the various innovations and infuse them in software, resulting in upgrades and improved services (Hippel, 2002:3). In an e-School, users (students, teachers, administrative staff, and community members) have various knowledge bases that can support innovation during the integration of the information system into the curriculum. If properly documented, such an innovation can act as an effective resource for improving the e-School system.

2.4 The E-School Success Model

The suggested augmentations and re-specifications of D&M's IS Success Model above are consolidated in the proposed E-School Success Model shown in Figure 2.4.

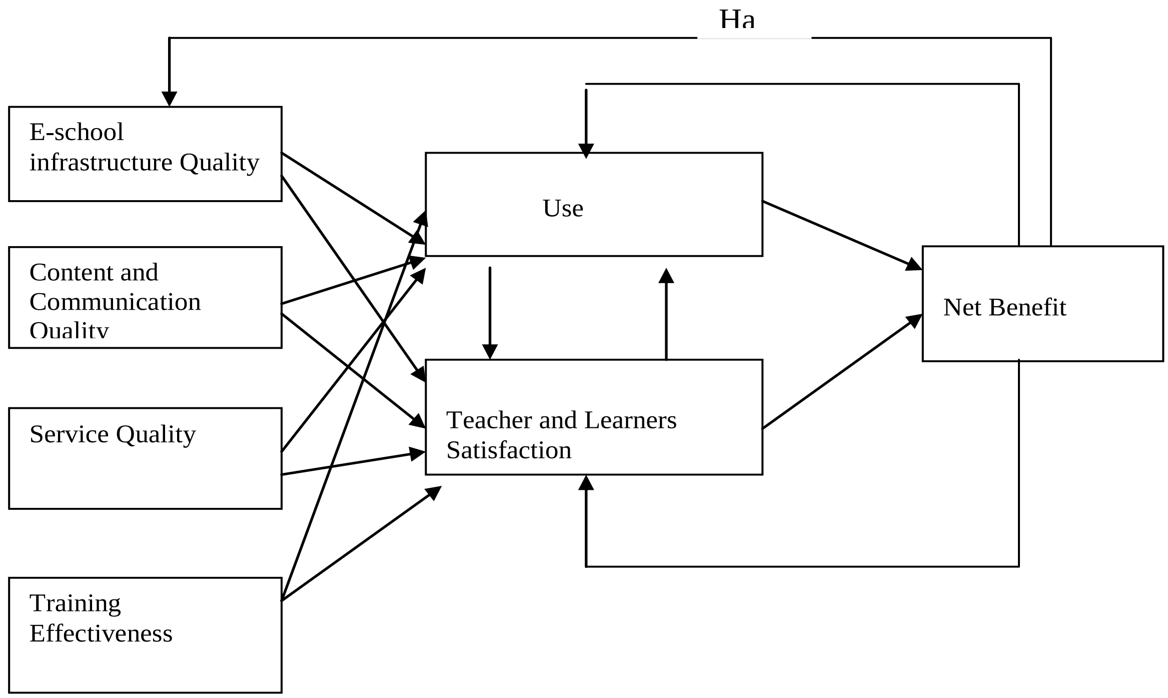

Figure 2.4: Modified D & M Model for e-schools

The proposed E-School Success Model, which is developed from D&M's (2003) IS Success Model, consists of seven dimensions, namely infrastructure quality, content and communication quality, service quality, training effectiveness, use, teachers' and learners' satisfaction, and net benefits. The dimensions on the left individually and jointly influence the dimensions on the right as articulated by DeLone & McLean (1992). Therefore the availability of suitable infrastructure and provision of quality services is expected to encourage teachers and students to use the system and even moderate the intensity of use. Teachers and learners who use a 'good' e-School system can be expected to develop a positive attitude and therefore perceptions about the system and derive some satisfaction from use of the system. Use and user satisfaction result in benefits such as improved learning, inculcation of teamwork among learners, and easier administrative task completion. As shown in the proposed model, the accrual of these benefits motivates users to continue using the system, meaning that users may derive even more satisfaction. The remaining three dimensions to the left (content and communication quality, service quality and training effectiveness) impact on both the use of the system and users' (teachers' and learners') satisfaction with the system, which in turn contribute to net benefits.

In the proposed E-School Success Model, the dependent variable is *e-School system success*. The success of the e-School is moderated by the following independent variables:

v_1 - Infrastructure quality

v_2 - Content and communication quality

v_3 - Service quality of technical staff

v_4 - Training effectiveness

v_5 - Use

v_6 - Teachers' and learners' satisfaction

v_7 - Net benefits

2.5 Measurement of e-School system success

This section outlines the dependent variables of the proposed E-School Success Model and highlight aspects of the seven dimensions which should be measured in evaluating the success of an e-School. The measurement items borrow heavily from tools that have been implemented in evaluating corresponding dimensions as recommended by DeLone and McLean (2008).

2.5.1 V_1 - Infrastructure quality

The e-School is endowed with ICT equipment that is connected through a network. Computer equipment for e-Schools most often includes computer workstations that are connected to printing and projection peripherals. The quality of the infrastructure may be investigated from both the hardware and software perspectives. The quality aspects that are proposed include:

- Reliability (security, integrity, coherence and error frequency);
- Effectiveness (performance and efficiency);
- User friendliness (ease of use and help features); and

- Maintainability (compatibility).

The quality aspects are measured from analysis of system documentations and reports on their operational effectiveness.

2.5.2 V_2 – Content and communication quality

The content (learning objects) in an e-School system resides in the electronic material used to support curriculum delivery. This material is mostly housed in e-textbooks, lesson notes, and recorded lessons (video and audio). In some cases, relevant material from the World Wide Web is downloaded and adapted to fit the curriculum. Communication here refers to the retrieval of documents through a network, downloading and uploading material, and e-mail transmission. Learning content should be relevant to the curriculum, exposing learners to information that falls within their scope of understanding. The layout of the online content should be such that navigation (searching, selecting, reading, etc.) easily facilitates back and forth movement. Quality aspects of content and communication include the accuracy of the content and information, and completeness, format, reliability and timeliness. Reliability in a communication system is very critical to an e-School. The learners and teachers rely on it to exchange material and ideas. In particular, the teachers require an effective communication system to support learners through the network after school hours. Learners should be able to access learning objects without delays associated with, for example, download or upload speed.

2.5.3 V_3 – Service quality

E-School users (learners and teachers) occasionally need support or someone to provide troubleshooting assistance when the system appears to be malfunctioning. One workstation could, for example, fail to connect to the internet while all the other workstations in the laboratory are connecting easily. Identifying the source of the problem may require the services of an experienced user or an expert. The services of IT staff become more urgent when a network-wide problem arises during instruction or when learners are on a programmed synchronous session. The speed at which the problem is sorted out, the systematic approach to resolving the problem and the response (attitude and helpfulness) and explanations provided, all add to service quality**.** In order to measure service quality, an assessment is made of the customers’ expectations of service quality on the one hand and perceptions of actual service quality as observed by the users on the other. The variance between expected service quality and observed service quality are obtained. This is repeated with every measurement item and the average computed. Large variance indicates poor service quality.

2.5.4 V_4 – Training effectiveness

In the school environment, most e-School users are new to the utilization of ICTs. The users (learners and teachers) need training to enable them to use the system successfully. The school population is generally large and the time available for training has to be negotiated (school recess for teachers but after school hours for students). Because only a few teachers can be taken for training at a time, a cascading model makes sense as the (trained) teachers are then tasked with training their colleagues. The expectation in this model is that learners will be inducted into the system by their teachers.

Generally, there are two main approaches to training, namely computer-mediated and facilitator-mediated training. Studies reveal that there is really no significant difference between the different approaches to training. However, different approaches to training serve different purposes. For example, while the instruction-based approach is suitable for information retention, behaviour modeling is more appropriate for hands-on experience (Chou, 2001). Facilitator-mediated training could either take on the lecture approach, or behavioural-modeling. Behavioural -modeling tends to work best in computer training, while the lecture approach facilitates the delivery of cognitive knowledge. This study identifies the different training approaches trainees encounter and determines the perception of trainees on the effectiveness of the training.

2.5.5 V_5 – Use

Cuellar, McLean & Johnson (2006) define 'information system use' as the extent to which an information system is incorporated into the user's operations. The operation at hand in e-Schools includes learning, teaching and the management of schools. Therefore this study evaluated the use of the e-School as it pertains to learning, teaching and management. Specifically, the evaluation assesses whether the system is used to improve the quality of students as envisaged in the mission of the e-Africa Commission. The attributes of use that were evaluated include: faithfulness in use, instrumentality of use, attitude towards appropriation, consensus of appropriation, and the context of use.

2.5.6 V_6 – Teachers' and learners' satisfaction

A system user makes an evaluative judgment of the entire system and voices his/her level of satisfaction or absence of the same. A user who is not satisfied with a system voices his or her concerns through complaints. The intensity of these complaints can be measured by asking the user to list complaints under various aspects of the system. The complaints are then represented on a Likert scale in order for the user to rate the intensity of their complaint. The assumption in this study is that the low intensity of a complaint signifies a higher level of satisfaction. The e-School system's users were asked to indicate the intensity of their complaints with respect to system infrastructure quality, content and information, ease of use, format, timeliness, and training effectiveness.

2.5.7 V_7 – Net benefits

Some of the much publicized expectations of e-Schools include: improving the quality of graduating students, demonstrated by their capacity to participate in lifelong learning (Condie & Livingston, 2007); enabling the graduates to enter the world of work easily and without necessarily seeking additional training; and enhancing students' teamwork skills in the work environment. In order to achieve these goals, ICTs must be successfully integrated into the education system. Although these benefits are largely intangible and difficult to measure, they may be inferred from students' improvements and changes in the performance index of the e-School compared to the performance index of the school prior to the implementation of the e-School system. In tandem, public expectations of improvement may be reflected in their increased approval of the school.

2.6 Summary

This chapter reviewed DeLone and McLean's (2003) IS Success Model and appreciated the re-specifications that have been made by other researchers. Subsequently, this researcher contextualized the dimensions of D&M (2003) to the evaluation of the e-School. A justification was provided for introducing training effectiveness as a dimension to the e-School and how it fits as a substitute for the 'intention to use' dimension in the D&M (2003) IS Success Model. The chapter highlighted aspects of e-School success variables that should be given prominence in evaluation.

CHAPTER THREE

LITERATURE REVIEW

3.1 Introduction

Integrating information and communication technologies (ICT) in teaching and learning has received much attention over the last decade and continues to be viewed with enthusiasm. This is despite the seeming dearth of rigorous studies supporting the positive outcome of ICT in education initiatives in literature (Livingstone, 2011). Proponents of ICT integration in teaching and learning theorize that benefits include improved students' performance, increased capacity of graduates to participate in the knowledge economy, and increased readiness for lifelong learning. These benefits are in line with the objectives of the NEPAD e-School project, which aims to empower students graduating from secondary schools with the skills they need to succeed in the knowledge economy of the 21st century.

Studies have reported mixed findings in different projects on ICT integration in teaching and learning, with some reporting positive outcomes and others negative or inconclusive findings. Hitherto, single study reports have not been replicated in similar projects, restricting generalization to specific study populations (Bokhove & Drijvers, 2011). Researchers doubt these findings are strong enough to be used in predicting possible outcomes of ICT integration in education on a broader scale or with a wider population.

This literature review discusses the performances of a variety of ICT integration initiatives in teaching and learning in different countries, compares the objectives and approaches of those projects to those of the NEPAD e-Schools, and establishes the extent to which the success or lack thereof in other countries' projects may inform the improvement of NEPAD's e-School implementation. The literature reviews the structure of e-Schools, their ICT infrastructure, the training that users (teachers and students) receive, and the reported benefits of the e-Schools. This is followed by a discussion of the implications of the other e-School projects' success on the NEPAD e-Schools' implementation

3.2 Understanding the e-School concept

The application of computer systems in teaching and learning has changed in structure and form over the years (Davis, 1997). Initially, such systems supported teaching and learning mainly as a type of storage, retrieval and communication system that facilitated connection between teachers and learners located anywhere at any time. The system was treated as a replacement for the library because it was a highly convenient way of making catalogues and reading materials ubiquitously available within the same media. The added advantage of electronic communication between teachers and students was that it served to increase the teaching and learning time with extended consultations (Vaan Braak, 2001; Fadel & Lemke, 2006). However, these configurations did not have the desired effect of drilling comprehensive subject knowledge into users of the system. A number of individual projects targeting improvement in specific competencies, for example algebra (Bokhove & Drijvers, 2011; Interactive Educational Systems Design Inc., 2003) and language (Poulsen, 2004), have since been developed and tried. In these projects, however, the teacher offers very little intervention and learners are not exposed to social interactions with peers and expert coaches.

A strand of computer applications in schools that integrate ICT in the teaching and learning process in a way that simulates the teaching environment has gained momentum in both developed and developing countries (Yuen, Law & Wong, 2003). Studies show that in this strand, infrastructure that includes people, technology and society is given much weight in the implementation process (Donnelly, McGarr & O'Reilly, 2011). A suitable system for ICT integration in teaching and learning therefore facilitates the interaction between the teacher, student and society through computer artefacts. From this perspective, the system for ICT integration in schools has improved the original version that consisted of four subsystems - students' sub-system, teachers' sub-system, library sub-system and administrative sub-system (Nobles et al., 1989) - by extending the communication component to bridge the gap between the school and larger society.

The structure of the e-School as envisioned facilitates productive interaction between stakeholders. Specifically, the structure enables teachers and students to interact among themselves and with databases to foment expansive learning that is geared towards problem solving (Engeström & Sannino, 2010; Engeström, 1987).

According to Uden and Beaumont (2006), problem solving through critical and creative thinking is one of the most desired characteristics in the workplace today. It is partly infused through cooperative and lifelong learning. Key elements supporting the integration of ICT in education are access to ICT infrastructure, availability of relevant content, availability of internet connections, and the endowment of skills to exploit the resources (Sife, Lwoga & Sanga, 2007). Installation and diffusion of infrastructure appear to be the most fundamental steps in all ICT integration initiatives. Sa´nchez, Salinas & Harris (2011) believe that for the successful use of the infrastructure, universal access (to the infrastructure) in students' living areas (homes) and classrooms would be helpful. This provides students with flexible access to the resources whenever the student finds it necessary to interact with the resources or with peers. Users of such resources should enjoy seamless interaction, meaning that the communication infrastructure should use software that encourages collaboration and facilitates knowledge sharing through networked communities. Systems with this capability make it possible for members of networked communities to identify peers and mentors with relevant knowledge and shared interests (Yang & Cheng, 2008). Theoretically, a well planned and implemented model of ICT integration in education should result in better outcomes, particularly with respect to students' skills and performance. The hitherto absence of corroborated reports confirming positive outcomes may be a consequence of poor design and implementation or the lack of longitudinal studies to trace these outcomes.

The design of the NEPAD e-School project envisages the diffusion of ICT infrastructure within the e-Schools. The objective of infrastructure provision does not address access to the infrastructure outside the e-Schools. In the next section, a synthesis is made of ICT infrastructure diffusion in e-Schools in Australia, Chile, Malaysia and the United Kingdom, with the aim of comparing these projects to the structure of NEPAD's e-Schools.

3.3 ICT infrastructure

The realization of ICT integration in curricula delivery begins with the availability of requisite infrastructure, assuring the quality of this infrastructure, and making these resources widely accessible and sustainable. Many schools and nations fail to implement e-Schools when resources for installing infrastructure are not available or when it becomes impractical to sustain the existing infrastructure. The cost of ICT infrastructure development and maintenance is enormous, and this explains why many e-School initiatives have remained at pilot stages in most countries. The cost of infrastructure is further exacerbated by the high rate of technological obsolescence. In implementing a project over several years, changing technologies require the replacement of the already installed infrastructure even before the infrastructure is diffused to other areas.

The next subsections discuss these issues as reported in literature and elucidate on how these should inform the success of the NEPAD e-School programme.

3.3.1 Quality

ICT infrastructure is suitable for e-learning when it is reliable and easy to use to the extent that teachers and students can concentrate on its exploitative use in an environment that is free of frustrations. For example, teachers are expected to develop course materials cooperatively with their peers in other e-Schools and provide support to students at any time. In developing and sharing course materials, teachers require adequate multi-media resources and an efficient communication network (Encarnação, Mengel, Bono, Böhm, Borgmeier, Brisson-Lopes, Hornung, Knierriem-Jasnoch, Koch, Krömer, Lindner, Paris, Sandberg, Schnaider, Storck, Teixeira, Urban & Wang, 1998). Multi-media resources should enable the teachers to combine content from different electronic formats while an efficient communication network should facilitate the transfer of content from one point to the another between collaborating peers.

In order to further extend the services to the student, e.g. for the student to access the services at home, the connection between the school and the community or homes should facilitate seamless interaction between teachers and learners outside the school environment. This requires access to an efficient internet or wide area network (WAN) (Venkatesh, Kruse & Chuan-Fong Shih, 2003). Communication within e-Schools, for example when helping a learner to grasp content (scaffolding) or when teachers in e-Schools are exchanging resources rich in multimedia, requires high capacity bandwidth to support interconnectivity. For this reason, broadband access has become mandatory for schools participating in ICT integration in teaching and learning in successful economies. To meet this high infrastructure quality, the NEPAD e-Schools' design incorporated the services of the RASCOM satellite which is dedicated to providing communication links between locations in rural Africa.

Quality ICT infrastructure that is suited for blended learning should include: computers of a good hardware specification shared at a low student to computer ratio in the classroom; an effective and reliable local area network that facilitates efficient communication and the sharing of data; presentation/projection equipment in the classrooms; storage of e-resources; printing facilities; a multimedia resource centre; and an internet connection that facilitates links between e-Schools and other databases (Abrami, Bernard, Wade, Schmid, Borokhovski, Tamim, Surkes, Lowerison, Zhang, Nicolaidou, Newman, Wozney, Peretiatkowicz, 2006). It is, however, envisaged that as modernization continues, schools may have to take advantage of the convergence of technologies and optimize the use of hand held computing equipment that may ultimately reduce the cost of infrastructure installations and facilitate access through mobile networks (Metcalf II & De Marco, 2006).

Literature on e-Schools indicates that different countries have different levels of quality of ICT for curricula delivery. For example in Australia, state and territory governments are responsible for education and schooling and provide (among other things) support for ICT infrastructure development (Pearson, 2003). However, ICT integration in education in secondary schools is at different stages of implementation in Australia. Some schools have found it difficult to raise additional funds for infrastructure development while others have complained about the timetable clashes caused by a small number of computers installed in a few computer laboratories. In a few schools, there is no mention of challenges associated with infrastructure (Neyland, 2011; Hayes, 2007). This variation is epitomized in a report by one school where previous network and infrastructure problems had caused some teachers at the school to become disillusioned about using technology in their classes. Neyland (2011:13) writes, "The teachers obviously got upset and distressed. They didn't want to have anything to do with computers because the things didn't work." Such negative experiences have long lasting effects that may discourage users from exploring the use of ICTs any further. In an attempt to address such shortcomings, the NEPAD e-Africa Commission instituted an e-School implementation framework that incorporated the participation of experts from consortia in the private sector (Evoh, 2007).

In a more sustained approach to infrastructure development, the Chilean government has implemented and encouraged the use of digital technologies in schools longitudinally, beginning early in 1990 through the Enlaces Programme (Sanchez & Salinas, 2008; Kozma, 2008). Enlaces has had a long history with ICT for education, having started as a private concern in the 1980s before it was given the national mandate in 1990 (Sanchez & Salinas, 2008). The programme is charged with the responsibility of distributing and installing computers, training ICT coordinators, and providing support on preventive maintenance. A second phase of the Enlaces project was initiated in 2002 with the launch of the Fondef-TICEDU Programme (Sanchez, Salinas and Harris, 2011). The programme has engaged efforts of experts from universities who work in developing specialized software and designing pedagogies for ICT integration in education (Sanchez & Salinas, 2008). This approach is informed by policy, resulting in the equitable distribution of resources and the installation of an approved system countrywide. The aspect of collaboration with universities at regional level facilitates the integration of new knowledge generated through research into the ICT initiatives. In this arrangement, best practices may be used in identifying and installing the most appropriate infrastructure available on the market, but which integrates well with equipment using old and new communication protocols.

The structure of the Enlaces e-School programme has the potential for sustainability and innovative improvement. An outfit such as Enlaces requires sustained collaboration with ICT experts to advice on improvements in the innovative use of the e-School. This is lacking in NEPAD's e-School implementation where the contracted consortia mandate is limited to installation of the e-School. The NEPAD e-Africa Commission is very unlikely to consolidate the kind of expertise domicile in institutions of higher learning with respect to the innovation of ICT integration in teaching and learning.

The development of ICT infrastructure for integration in education is also founded on a systematic approach to implementation. The Ministry of Education of the Malaysian government conceptualised Smart Schools in 1997 and identified 90 schools which were used as pilot centres. The Smart School project was developed to take advantage of the multimedia super corridor and also to identify a way of extending ICT to the rural areas of Malaysia (Indrus & Atan, 2004; Pandian, 2002). The Malaysian government was aware of the digital divide between rural and urban schools. To bridge this gap, a Mobile Internet Unit (MIU) was set up with the objective of creating awareness and enhancing the literacy of ICT in rural schools. This unit was provided with a luxury bus fitted with computers that were connected to the internet (Indrus & Atan, 200436). As the unit visited schools to create awareness, it also collected data pertinent to network propagation and forwarded these to the Ministry of Education. This was necessary to facilitate decisions on the most suitable infrastructure for regions where internet access was unavailable. The pilot project is on course, but no new schools have been added to the project due to the challenges of resource mobilization and impact assessment.

This challenge is not unique to Malaysia. Different sectors are competing for resources, and bureaucrats are normally tempted to allocate more resources to those sectors which, in their opinion, lead to immediate rewards. ICT integration in education has not demonstrated rapid positive outcomes, resulting in the low relegation of its funding on the list of priorities, and particularly where policy is not well articulated. This fate may be befalling NEPAD's e-School initiative. Since the implementation of the pilots in six schools in Kenya in 2005, no other schools have been added to the project. Funding, however, is just one of the barriers to the rapid diffusion of e-Schools (Yildirim, 2007).

The integration of ICT in education has had a long history in the United Kingdom. Indeed, the UK has had varied activities with technology in schools dating back to 1970, and it contends to be the world leader in ICT integration in teaching and learning in schools (Watson, 2001). The initiative is government led through policy and has seen massive investment in ICT for schools that resulted in the increase of the student to computer ratio to 18 students per computer by 1998 (Watson, 2001). This ratio is currently approaching one student per computer in some schools. The schools are, however, required to support the large capital infrastructure with self generated funds (Mee, 2007).

The degree to which UK governments, for example, has pumped funds into ICT projects in schools has been so high compared to documented benefits, that some researchers have cautioned that it may be counterproductive (Mee, 2007:70). Despite these government's initiatives, the quality of infrastructure is not uniformly high in all the schools in UK, an outcome explained by the complexity of policy (Younie, 2006). The policy for ICT implementation in the UK gives roles to multi-agencies in the process. This, according to Younie (2006), confuses the market in certain aspects and depicts lack of leadership. The key revelation here is the duplication of efforts and non-unified skills stock among teachers and technical staff. Different schools procure training services from institutions which are competing and therefore do not use the same curricula. The schools are also free to seek funding from different agencies resulting in the inequitable distribution of resources as some schools are more successful in fundraising.

In effect therefore, the UK e-Schools do not have the same ICT infrastructure installed despite the initiatives being guided by policy. The quality of infrastructure may therefore vary from one region to the next, meaning that their impact may not be comparable.

To the extent that e-School success requires cooperative learning and self-directed learning, assuring quality of infrastructure in one e-School while neglecting the others negates the essence of collaboration as students' and teachers' efforts to engage with their peers result in frustrations. Therefore, a system development approach to ICT infrastructure diffusion at a wider regional level is necessary for the realization of the goals of ICT integration in teaching and learning. Of the four countries reviewed, Chile appears to be using the right strategy to regionally ensure the quality of infrastructure. Schools are grouped into regions, and each region is assigned a university to oversee development in the technological arena and provide desired training to the teachers. Consequently, within a given region, the quality of ICT infrastructure is to an extent defined by the overseeing university. Students and teachers in different schools within a region therefore enjoy a similar level of ICT infrastructure quality. The quality in the different regions is, however, not expected to be very different. Based on their mandates, universities conduct research which is shared through publications. This, together with the reality that no one university would be comfortable with the tag of 'laggard', makes it possible for competition at regional level, resulting in generally good ICT infrastructure quality being implemented in all the schools in Chile. An improvement in this competition could be achieved if the universities' funding was pegged to milestones in the diffusion of effective ICT infrastructure. This arrangement would necessitate the creation of an oversight body that conducts regular evaluations of the e-Schools nationally and provides rankings of the regions according to the extent to which the shared objectives are achieved.

The NEPAD e-Schools are yet to be diffused on a national scale in Kenya. The e-Africa Commission could borrow a leaf from the Enlaces programme in its approach to assuring the quality of ICT infrastructure at regional and national level. This could be achieved by appointing county (new administrative regions in Kenya) and national mentoring authorities that are guided by common policies.

3.3.2 Accessibility

The successful integration of ICT in teaching and learning where infrastructure has been established depends partly on the extent to which the infrastructure is accessible. Infrastructure should be accessible to the students, teachers, and the section of society that participates in the mentoring of students. Therefore, for their effective use in e-Schools, ICTs should be well distributed in classrooms, teachers' workstations, and students' living areas. With wide access to infrastructure, students and teachers have the opportunity to interact within the classroom and outside class hours when individual students may seek coaching from an expert who may be within the school or in the community (Culp, 2010; McLoughlin, 2002). Extended access to infrastructure in the classrooms facilitates teachers' use of the infrastructure in everyday classroom teaching. The teacher should be a facilitator to students in inquiry-based learning where tasks are given to students to develop solutions with the use of the resources available within the e-School network. Such an approach to learning, it is believed, should lead to a higher contribution to the integration of ICT in teaching and learning with possible improvement in the learning outcome (European Schoolnet, 2006).

The interaction between students and ICTs is partly driven by the nature of available content. Content may serve to entertain, inform or educate. Students use ICT for any of these purposes. However in the classroom environment, priority should be placed on content that is relevant to the curriculum. Content that is relevant to the curriculum may be a repository in the local area network; retrievable from a location within the wide area network of collaborating networked schools; available in an internet cloud; distributed by a member within the network; or part of education software provided by the school. Initially, content may be supplied by the agent installing the ICT for the schools. This may be maintained centrally by the education regulatory authority as in the case of Australia (Powell & Patrick, 2006). Content may also be accessed from a vendor such as an academic database manager or distributed in memory to the schools during system installation.

Related studies show that in most e-School projects, ICT for learning does not have content that is specific to the curricula. School textbooks have not been digitized for incorporation into the e-School systems, partly due to the implications of cost and partly due to intellectual property rights issues. In the few instances where the content available is relevant, students tend to engage with the ICTs much more (Reynolds, Treharne & Tripp, 2003). The unavailability of relevant content is a draw-back to the success of ICT integration in teaching and learning. Hardware and software alone without content distribution through the communication sub-system is inadequate for inquiry-based learning.

Some content may be generated collaboratively between peers within the network. For example, teachers in networked schools may develop content relevant to teaching but not available in an organized form that they feel is suitable for use by their students. Teachers could also collaboratively develop content which could feed into publishable books, but instead avail these online for students in collaborating schools. Students are also known to collaboratively generate content through participation in group projects. In certain cases students may, through normal debate over a subject, come up with credible information that may constitute new knowledge (Johnson, Levine, Smith & Smythe, 2009). Debate on the authenticity of such knowledge persists, and institutions are reluctant to accept such content when it is generated by students (Wheeler, Yeomans and Wheeler, 2008). However, even the online publication of such content, irrespective of its admissibility to the academic community, may motivate participating students and sow the seeds for more credible knowledge. Part of such content may be used as case studies by teachers in their classroom teaching.

In Australia, the schools that are participating in ICT integration for teaching and learning have made an impressive advancement with 75% having developed intranet facilities to increase the sharing of information within the e-Schools (Baskin & Williams, 2006:10). The software used in the schools is provided centrally by the government, but some schools depend on local innovations or purchase off-the-shelf products to improve the performance of the centrally supplied modules (Baskin & Williams, 2006). Baskin & Williams (2006:8) found that a small proportion (19%) of the schools had developed in-house software that was reliant on the expertise of a few teachers, but suggested that if these teachers were transferred, the projects would likely stall.

Despite the Chilean government's concerted efforts to expand ICT infrastructure in schools, challenges still abound. Over time, the access to ICT infrastructure in Chilean schools has improved, with the student to computer ratio increasing to 23 students per computer, and internet access being availed to 75% of the students enrolled in the education system. In 2009, broadband was accessible to 67% of the student population at national level (Enlaces, 2009). However, the general frequency of use of the accessible infrastructure is low (Hinostroza, Labbe, Brun & Matamala, 2011). In secondary schools, classrooms access computer laboratories three times a week. This suggests that the general level of integration of ICT in everyday classroom teaching is low, and may explain why universities have been mandated by the Ministry of Education to train teachers and work with groups of schools to develop alternative pedagogical approaches to ICT in education (Light, 2009; Hinostroza, Hepp and Cox, 2009).

In Malaysia, the schools included in the Smart School project have access to a central repository of digital resources and are provided with software for the Smart School Management System (SSMS) which facilitates student attendance records and provides teachers with a module for planning lessons (Hamzah, Ismail & Embi, 2009). SSMS also provides students with access authorization to the internet and interaction with learning content. However within the Smart Schools, the dispersion of ICT use in different subjects varies in Malaysia (Lateh & Muniandy, 2010). This is partly because right from the onset, the Ministry of Education placed priority on certain subjects in the project. For example, teachers of Islam in Education within the Smart School project are grappling with inadequate computers, lack of training and time constraints. The schools which are not included in the Smart School project are also not well resourced with ICT infrastructure and skilled teachers.

Access to ICT infrastructure in schools in the United Kingdom appears to be much better. Within the classrooms, there is at least one computer connected to a data projector that is fixed to the ceiling (Beacham, 2011). In addition, teachers have access to laptops which they can borrow and distribute to groups of students in the classroom. This has the advantage of providing access to ICT in places beyond the computer laboratory. It may not always be necessary for students to learn through computers, particularly where the development of ICT infrastructure is not complete. The strength of bandwidth required to sustain online connections to all the students in a school at any given moment may also be too high for the current level of technological development. Therefore for the optimum utilization of available resources and ICT integration, the option of borrowing laptops for class use may be ideal. This helps to reduce the time lost when students move from their classrooms to the computer laboratory and prevents the frustrations associated with the inability of teachers to secure space in those computer laboratories for their lessons. This arrangement could be made more effective if a set of laptops were reserved for a group of classrooms and there was an adequate number of technicians to support teachers with the distribution and setting up of laptops in the classrooms. The NEPAD e-School in Kenya may, however, find it challenging to get more personnel deployed to the schools for this purpose. Currently, schools in Kenya complain of disproportionate understaffing which the government cannot resolve due to limited funding.

Requesting for more personnel on account of the e-School is therefore likely to result in no-response from the government.

3.3.3 Sustainability

ICT infrastructure development and maintenance is very costly for a number of reasons (Ward, 2003). Firstly, despite the advancements in technology, the cost of ICT infrastructure and resources remains high in places like Africa because hardware and software have to be imported, requiring a large capital outlay for acquisition. Secondly, technological advancement is occurring very rapidly, resulting in the high obsolescence rate of existing technology. Institutions willing to keep up with the changes face the daunting challenge of rising costs associated with the frequent replacement of existing technology with new technology. Thirdly, technology requires skilled manpower. These individuals must continuously develop their skills to keep up with the changing technologies.

In effect therefore, whereas governments and institutions may successfully source funds for initial investment in technology installation, the variability in advancement requires that the institutions continue to inject large financial resources into the maintenance of these technologies. The incremental costs may become a significant obstacle to ICT integration projects. One way of overcoming this challenge is ensuring that implementing institutions prepare themselves to maximize the benefits from opportunities offered by ICT integration, as suggested by Kessy, Kaemba and Gachoka (2006). In other words, institutions should consider a business model in the implementation of ICT integration in education. Such models ensure that the results of projects have tangible benefits that directly or indirectly facilitate the realization of returns that can be traced to the investment. Examples of benefits of ICT integration, such as the increased productivity of students in the industry, would have a positive impact on the economy and consequently persuade governments and philanthropists to support ICT initiatives and to continue providing support.

In Chile for example, the government continuously provides funding to support the schools' ICT infrastructure. While the government provides a large proportion of the funds, development partners such as the World Bank also make substantial contributions. The municipalities and the schools themselves also provide some level of contribution (Potashnik, 1996:10). In the United Kingdom, the policy in place authorizes individual schools to conduct fundraising initiatives (Mee, 2007). This has resulted in some schools building better infrastructure as they have strong ties with the technology industry. These arrangements show the determination of the central government to encourage independence and the sustainability of projects. At government level, a special tax revenue may be levied on industries to create a kitty for ICT infrastructure development and maintenance. Industries would find it noble to make contributions where they reap the benefits, as exemplified by the university-industry partnership in Canada in the development of ICT clusters (Bramwell, Nelles & Wolfe, 2008). Certainly, the nationwide financing of projects maintains pressure on the redistribution of resources to other areas within the education sector. Similarly, philanthropists who provide funding receive requests from various quarters and may prioritize disbursements based on relevance and positive outcomes. When funding from a particular source, whether from the government or industry, dries out, the e-Schools which were relying on such organizations have to find alternative sources of funding. Occasionally, such schools demand support from the parents, at least as a stop-gap measure. To the extent that this option increases the burden on parents, support may be achieved when the parents are convinced of the rewards of their contribution. It is these rewards or positive outcomes that have been lacking in ICT integration in education projects that may discourage parents' voluntary contribution. In the case of the NEPAD e-School initiative, studies have not been conducted to trace these benefits and therefore the current study is a contribution to filling this gap.

The other aspect of infrastructure that requires more attention in sustainability is network maintenance and internet provision. Maintaining ICT networks requires personnel who are highly technologically skilled. It has not been possible to develop enough skilled manpower in most developing countries to manage the infrastructure**.** To access resources from external databases, institutions require reliable and cost effective internet access. In a study of enabling and constraining ICT practice in secondary schools in South Africa, Hodgkinson-William, Sieborger and Terzolo (2007) established that schools in the Eastern Cape lacked technical support and did not have access to affordable internet connectivity. In Africa, internet access fees have remained high for the selfish reasons of internet service providers (ISP). ISPs make access costs high, partly because of limited competition, and partly due to the restricted availability of bandwidth resulting from the monopoly of governments in international gateway infrastructure. A similar situation can be observed in India where the pricing structure is considered flawed (Gumaste, Gokhala & Dhar, 2009:42). The Indian broadband access pricing model that is based on use tends to suppress demand. Gumaste, Gokhala and Dhar (2009) recommend the implementation of a flat rate pricing model, at least to excite demand as has been experienced in mobile phone expansion. However, without the introduction of more providers to the international gateway, the pricing model may not have an impact on subscription cost.

Institutions can, however, succeed in reducing the cost of internet access subscription by pooling demand and purchasing bundles of access rights. This requires a conglomeration of institutions through some corporate body with rules that govern the conduct of its members. A similar approach has been successfully implemented by universities in Kenya (Adam, 2003). Kenyan Universities access the internet through the Kenya Education Network Trust (KENET), an organization that was established through the funding of USAID to encourage the use of ICTs in learning (KENET, 2007). As a non-profit organization, KENET gets international bandwidth from Jambonet at 50% of the commercial rate available to Kenyan ISPs. Jambonet is the Kenyan National Internet backbone that was established in 2001 (Odero & Mutula, 2007). The establishment of organizations such as KENET requires supporting policies instituted by respective governments. Where governments are not willing to get involved, the product or service consumers may be forced to bear the burden of the high cost of access.

The case of Jambonet's provision of internet access to KENET at half the commercial rate suggests that with the right policies in place, the cost of international internet access may be drastically reduced in Kenya. Instead of the government making immediate large profits at the gateway, it could opt to reduce these profits as a way of increasing demand for internet services. As a result, revenue collection by ICT service providers would increase, making it possible for accelerated growth in the economy and therefore more tax revenue for the government. Specific to NEPAD e-Schools, the RASCOM Satellite is subscribed to by African governments, and this forms the basis for the Kenyan government to buy bundles of access rights and re-distribute these to the e-Schools.

The cost of this subscription should be manageable, and the unit cost should go down when the number of e-Schools sharing the available bandwidth increases.

There is a dearth of information on sustainability models adopted in the four countries' e-Schools. What is evident is continuous fundraising for the projects. The innovative participation of teachers in helping reduce the cost of content acquisition through their collaborative approach to e-resources' development for student learning, for example, is not reported in any of these projects. This is not unexpected. The projects are led by government bureaucrats who are not known for business approaches to programmes. It may be helpful if governments could emulate the approach of the Chilean government in implementing Enlaces. The e-Africa Commission should be managed by experts with entrepreneurial skills. Such experts would ensure that the decisions made are cost effective to the institutions and viable to the government in terms of improving productivity from which a re-financing model can be developed.

3.4 ICT education and literacy

The relationship between ICT diffusion and education is not conclusive. In an analysis of data from developing countries, Baliamoune-Lutz (2003:162) established that education and literacy appear to have no impact on the dissemination of personal computers. This is contrary to earlier findings by scholars such as Kiiski and Pohjola (2002). Baliamoune-Lutz (2003) asserts that the differences in the conclusions of various studies depend on the indicators used for ICT diffusion and also the locale. It appears that studies conducted in developing countries produce consistently different results from those conducted in developed countries. Theoretically, the utilization of ICT should be driven by the level of education, but the mechanism by which level of education drives utilization of ICT in developed countries is different from developing countries. A person with secondary education may use computers for entertainment, web browsing, e-mail communication and word processing. The range of these activities increases for a person with tertiary education. Tertiary education provides the capacity for a person to apply similar uses but at a more advanced level and more extensively, particularly when conducting research. In the school environment, teachers and students require different levels of ICT literacy to enable them to exploit the resources within their level of exposure and experience. The discussion that follows reviews trends in students' and teachers' ICT literacy and how the findings in literature can be used to improve practices in the NEPAD e-School initiative.

3.4.1 Students' ICT literacy

The modernization of technology is progressing very rapidly and calls for progressive skills development for a society to benefit from the interaction between technology and human capital for sustainable economic growth (De Feranti, Perry, Gill, Guasch, Maloney, Sanchez-Paramo, & Schady, 2003). The ideal environment for accelerating skills development is the school; the greater population of a nation undergoes some formal education in schools. Within the schools, the process of inculcating skills in learners is the responsibility of teachers, albeit with the support of parents and the community.

Students in the 21st century have had the opportunity to mess around with various technological devices and tend to be more at ease than their teachers when using technology. Their interaction with technology is driven by peer influence and not just the desire to know (Ito, Baumer, Bittanti, Boyd, Cody, Herr-Stephenson, Horst, Lange, Mahendran, Martinez, Pascoe, Perkel, Robinson, Sims and Tripp, 2010). They participate in numerous social networks and experiment more with emerging technologies, resulting in a competent skills' set when these technologies go mainstream. According to Ito, Baumer, Bittanti, et al. (2010: 39), the youth's participation does not have to be curtailed by the digital divide because they access technology in friends' homes and various social meeting places. Nevertheless, in a region with very low ICT penetration, a section of the youth will still suffer from the effect of the digital divide, even though studies show that access through cyber cafes (Rubagiza, Were & Sutherland, 2011) and mobile phones (Cavus, Al-Momani, 2011) are viable options in developing economies.

The small proportion of teenagers who reach secondary school before getting acquainted with basic computer technology require a lot of support from their teachers. NEPAD e-Schools are particularly affected by their rural environments where the diffusion of ICT is generally low and therefore students, at the time of admission, have very little if any ICT literacy. The e-Schools should assess entry level behavour to determine what training students should receive to help them use ICT for learning. Teachers who induct students should also appreciate that some students have very high expertise skills and can equally facilitate their peers and teachers when the need arises (Hakkarainen, Ilomaki, Lipponen, Muukkonen, Rahikainen, Tuominen, Lakkala and Lehtinen, 2000). It is argued that students learn best from their peers, and therefore giving students the platform to train their colleagues is an effective approach to achieving the training objectives. Such arrangements would also benefit the e-Schools in Kenya since the number of trained teachers who can induct new students is small. The challenges of this approach are competition for time with the main curriculum, limited ICT access points, and the large number of new students arriving annually.

3.4.2 Teachers and educators' ICT literacy

In order for the NEPAD e-School teachers to play their roles in inducting students into ICT, they must themselves seek and acquire skills in handling technologies to enable them to use tools such as computers in the classroom (Wood, 2002; Paraskeva, Bouta & Papagianni, 2008). Acquiring basic technical ICT skills, such as file management and word processing, tends to be easier, even though a good proportion of teachers still lack these skills in the developed and developing economies (Morris, 2010). On the other hand, the acquisition of pedagogical knowledge, i.e. how to use the ICTs to support learning, is a paradigm shift that appears to be of little interest to teachers (Erixon, 2010; Goodson, Knobel, Lankshear, & Mangan, 2002). Thus a large majority of teachers, including those who have basic ICT technical skills, lack pedagogical knowledge on how to integrate ICT in the teaching and learning processes. The teachers require both self drive and school support in acquiring knowledge and expertise in good pedagogical practices for ICT integration in teaching and learning (Drent & Meelissen, 2008).

With the launch of the pilot e-Schools, the NEPAD e-Africa Commission organized short training sessions for a few selected e-School teachers who were responsible for the transfer of skills to the other teachers in the e-Schools (Evoh, 2008). The training was, however, conducted by the ICT consortia organizations who may not have emphasized pedagogical training since they are technology and not educational organizations.

Pedagogy is the way teaching is conducted or the strategy that a teacher employs in the cognitive development of learners (Hinchliffe, 2001). It may also be viewed as methodological strategies of teaching. The pedagogy of ICT integration in teaching and learning is radically different from the pedagogy in traditional teaching. In the latter, the delivery of curriculum content is teacher-centered and dominated by didactic learning (Crawford, 1999). The teacher has the knowledge that is to be transferred to the learner, and the teacher approaches the transfer of knowledge from known content to the unknown. The learner in this environment is a passive listener and makes only minimal contribution to the learning process while refereed by the teacher (Smerdon, Burkham & Lee, 1999). On the other hand, the pedagogy for ICT integration in teaching and learning is student-centered. The learning approach is mainly inquiry-based or constructivist. The teacher in this situation is a facilitator who provides the learning objectives and steps aside to allow the student to investigate the subject matter as much as they can on their own**.** The students therefore construct new knowledge through the exploration of pre-existing knowledge (Duffy & Cunningham, 1996) and application in their contexts. The limitations of the learning may be defined by the cognitive skills mapped by the teacher, availability of additional materials, on subjects' extended knowledge, and learners' time constraints. A large majority of teachers in Kenya complete their formal education without experiencing the use of ICT in learning and are therefore less equipped with skills for ICT integration in the classroom. The e-Africa Commission must therefore take a leading role in training e-School teachers in ICT integration pedagogies.

There are several challenges linked to the training of teachers in inquiry-based learning pedagogies. Firstly, the training requires a paradigm shift in approach and therefore more time is required to inspire the change in teachers. Secondly, the teachers feel deprived of their authority in class. Traditionally, teachers imagine that proving the point to students that teachers have more knowledge is a form of authority. In inquiry-based learning, this assumption is challenged as the students navigate using available resources to construct knowledge with very little facilitation by the teacher. In practice, however, inquiry-based learning requires more time and other resources which are not provided in the existing curricula. This is very well articulated in a study by Hennessy, Ruthven and Brindley (2005), which established that teachers compete with time to complete the syllabus for the sake of realizing good examination results. The approaches to implementing ICT integration in teaching and learning are attempts to fit new ways into existing systems without analyzing the consequences. It may be helpful, in the Kenyan education system, to reorganize curricula in both scope and measurement to make it possible for teachers to implement new pedagogies in e-Schools without the fear of their students performing poorly as a result of incomplete coverage of the syllabus.

3.5 Exploitative use of ICT infrastructure

The approach to instruction delivery takes into consideration the learner's background, knowledge, environment and situation. These characteristics of a learner change with time and subject content. Consequently, pedagogies should be self-questioning to fit both the subject and the environment. It is therefore indubitable that when the practice of integration of ICT in teaching and learning is embraced in the classrooms, pedagogical approaches in traditional classrooms have to be replaced with those that support the independent and collaborative use of ICTs by students and teachers in the classrooms and after class hours. The application of ICTs in education endows students with resources that direct their efforts to obtain additional knowledge. Similarly, through interaction with peers and teachers using these resources, learners get the opportunity to refine their knowledge. Therefore the integration of ICT in education requires pedagogies that are student-centred. This is at variance with commonly held views among teachers and results in the sub-optimal exploitation of ICT infrastructure in education, as evident in the studies conducted in Australia, Chile, Malaysia and the United Kingdom.

3.5.1 Practices in Australian schools

In a study of how ICTs are used in the classrooms to mediate student learning in New South Wales (NSW), Hayes (2007) established that ICTs were being used to support existing classroom practices. There were no radical changes in the pedagogical approaches. Teachers in that study recognised that they required training and support to achieve the objectives of ICT integration. This support was given in an *ad hoc* manner – no training curriculum was provided. As observed by one of the ICT coordinator's who was interviewed in the study, the ICT coordinator inducts a few teachers who then do the same with their colleagues (Hayes, 2007). This approach has led to the slow pace of ICT integration and diffusion, even more so in schools where the school leaders appreciate the value pedagogical approaches contribution to the success of the integration (Neyland, 2007; Hayes, 2007).

In a similar study conducted in schools in the Sydney region, Neyland (2007) corroborated the finding that support for teachers in acquiring the right pedagogical skills is one of the main contributing factors to the slow pace of ICT integration in teaching and learning. Earlier studies in schools in Queensland had established that one of the obstacles to the diffusion of ICT use in the classroom was teachers' lack of competence in using these technologies (Janieson-Proctor, Burnett, Finger & Watson, 2006; Baskin & Williams, 2006). Janieson-Proctor, Burnett, Finger and Watson's (2006) study revealed that teachers who had no technical skills were actually advocating against the use of ICTs. Baskin and Williams (2006) also established that different schools were at different levels of ICT integration (low, medium and high) caused by an imbalance in the distribution of resources. This imbalance results in another form of the digital divide among schools in Queensland (Baskin & Williams, 2006).

According to the Perceptual Control Theory (PCT), technical skills are lower in hierarchy to pedagogical skills (Zao & Cziko, 2001). Teachers must be made to appreciate the value of attaining technical skills in relation to the higher goals of realising curriculum delivery. Once attitudes change towards technology, teachers may acquire technological pedagogical content and knowledge to apply the use of technologies in everyday classroom teaching and subsequently critically evaluate their classical pedagogies with a view to reform them (Bates, 2010). Education systems in Australia should consider developing a curriculum for teachers' professional development in the area of ICT integration in teaching and learning. The curriculum should provide a common course covering ICT technical skills followed by a course for pedagogical skills tailored to meet different subject requirements.

3.5.2 Practices in Chilean schools

The Enlaces programme conceived a holistic approach to ICT integration in teaching and learning that combined the diffusion of ICT infrastructure and the professional development of teachers. The training of teachers, as described by Sanchez & Salinas (2008), entails technology awareness and training in the use of the technologies in the delivery of the curriculum and therefore pedagogical approaches. The consortium of public and private universities, hardware and software companies, telecommunications companies, and other public and private institutions charged with overseeing Enlaces, has the ability to provide teachers with support in pedagogical development (Sanchez & Salinas, 2008).

The approach to training teachers in Chile is systematic in the sense that it deals with technical skills first. By 2002, up to two thirds of the teachers in the country had received training on the use of e-mail, the internet, productivity software and administration (Kozma, 2008). Training was achieved through seminars and covered all the participating schools. Despite these efforts, the diffusion of ICT use in the classroom in Chile is not profound and the pedagogical approaches are at best superficial (Sanchez & Salinas, 2008). ICTs are not frequently used in the classrooms, with the average number of activities using ICTs being 1.8 on a scale where 1 represents 'one or two lessons per year', 2 represents 'some lessons per semester', 3 represents 'some lessons per month', and 4 represents 'in almost all lessons' (Hinostroza, Labbe, Brun, Matamala, 2011:1361). It is probably this low frequency of use of ICT in the classroom and the superficiality of pedagogies of ICT integration in teaching and learning that account for the lack of impact of ICTs on students' performance in Chile (Cox & Marshall, 2007).

It is, however, conceivable that the level of infrastructure diffusion may not be adequate for the full liberalization of ideal pedagogies for ICT integration. With the access points restricted to the computer laboratory, Evoh (2007) found that teachers cannot provide personalised support to students after class and students cannot explore more knowledge in their free time. In an ideal situation, teachers should let students use the ICT resources to explore knowledge both inside and outside the classroom while following a constructivist approach. During breaks or after school, students should have opportunities to interact with peers and teachers online to learn collaboratively and get the one-on-one support of a coach. These conditions require a very high student to computer ratio (1:1) and an equally high student to teacher ratio which has not been achieved in Chile despite Enlaces two decade long existence (Enlaces, 2009). A similar situation is highly conceivable in the NEPAD e-Schools.

3.5.3 Practices in Malaysian schools

The Ministry of Education in Malaysia has developed a cascading model for the training of teachers on ICT use where ICT coordinators are provided with train-the-trainer skills. The coordinators then train teachers in their respective schools. The model has been slow to pick up, although there has been progressive improvement in the proportion attaining ICT skills; between 1997 and 2002, some 55,000 teachers in Smart Schools had received training (Foong-Mae, 2002:4). The other contributing factor to the slow pace of teacher training in Malaysia has been the policy on the diffusion of technology. Smart Schools house computers in special computer laboratories, but there aren't enough computers, laboratories and other infrastructure to meet the needs of students and teachers (Hamzah, Ismail & Embi, 2009). In other words, technology is not widely accessible to the school's community members. The up-skilling of teachers is now being undertaken through teacher training programmes (Bakar & Mohamed, 2008). Bakar and Mohamed (2008) found that trainee teachers were confident that they had the capacity to integrate ICT in their classroom practice. Nevertheless, the environment and the culture in Smart Schools may dampen this enthusiasm.

Other than the problems of accessing ICT infrastructure, teachers are also constrained by time. The culture in Malaysian education imposes the 'complete the syllabus' syndrome. Teachers are therefore always rushing to deliver content and do not have time to think about pedagogies (Hamzah, Ismail & Embi, 2009). Some studies have, however, revealed that teachers are not willing to participate in online collaborative learning (OCL) (Ah-Choo, 2008). In a survey of 12 secondary schools, Ah-Choo (2008:5) found that 50% of the teachers were undecided on their readiness to embrace collaborative learning. The study also revealed that 58% of the teachers were not sure they would find time for collaborative learning. For the teachers to effectively participate in OCL, they would require support from the leadership (principals of the schools). The nature of this support should include professional development, improved access to ICTs, and a reduced workload to enable the teachers to plan lessons and incorporate innovative pedagogies.

The pedagogical practices in teaching in Smart Schools are therefore in a stage of transition. A contingent of like-minded teachers with requisite ICT skills has to be created for the schools to move forward. Furthermore, the point of access to ICTs should be evaluated. Teachers should be able to access ICT infrastructure from the comfort of their offices or staff common rooms, and students' access should be extended beyond the laboratories.

3.5.4 Practices in schools in the United Kingdom

The UK e-School programme named Sholar (was designed to complement without replacing traditional pedagogies (Condie & Livingston, 2007). The resources of Scholar are being used in ways that enhance learning and improve students' skills in collaborative and lifelong learning. In a study to find the extent to which teachers' practices had been influenced by the introduction of the e-learning component, Condie and Livingston (2007) established that: (i) Teachers involved with Scholar felt that they were confident and competent in using computers, (ii) The teachers had a technical knowledge of Scholar but not specific pedagogies for integrating ICT in teaching and learning, and (iii) Scholar was seldom used as the main resource for teaching and learning. These findings suggest that the capabilities of Scholar are not being fully exploited.

There are concerted efforts being made for teachers' professional development in ICT. In the period spanning 2000 to 2003, the funding level of teachers' professional development in ICT had increased to £ 230m (McCarney, 2004:61). Teachers' training is mandatory in UK policy (Davis, Preston & Sahin, 2009). An organic approach to the training of teachers has been developed and leadership provided through the establishment of a higher-educational institution for teachers in the UK (Davis, Preston & Sahin, 2009b). The training of teachers is school-based and combines face-to-face teaching with blended learning. Despite this, blended learning is rarely used by teachers (Davis, Preston & Sahin, 2009b).

The training of teachers does not provide them with customised pedagogical practices. Instead, teachers are left to discover innovative pedagogies for integrating ICT in teaching and learning without the programmed support of the education authorities. In a study to explore teachers' development of practical theories on effective pedagogies, Deaney, Ruthven and Hennessy (2006) established that teachers, through experience, try what they conceive as good practices and modify these approaches until they succeed. This is similar to the results of a study on how pedagogy is developing in response to the influx of interactive whiteboards in schools in the UK (Hennessy, Deaney, Ruthven & Winterbottom, 2007). Such exploration may result in useful new knowledge and therefore practices. For example, in an action study into the 'dialogic approach' to classroom interaction and its relationship to the use of whiteboards in orchestrating classroom talk, the insight of the teacher-researcher formed the basis of staff development in her school on pedagogical practice (Warwick, Hennessy & Mercer, 2011). These approaches to identifying pedagogies are time consuming, which discourages teachers from attempting them. The process of innovating practices is involving and time consuming and clashes with the already heavy workload of teachers.

3.6 Perceived impact of e-Schools

Constructivist teaching has created new dilemmas for the teaching fraternity because its implementation is challenging (Windschitl, 2002). ICT integration in teaching and learning has offered relief because it provides tools to support constructivism. Schools that have successfully experimented with the integration of ICT in teaching and learning report that it provides the best pedagogical approach to teaching, suggesting that those teachers who have not changed to embrace the use of technology should be convinced to do so (Neyland, 2011). E-learning places at the disposal of students, database resources, and facilitates the creation of networks between students and teachers. Students have the opportunity to refer to online resources to access elaborate explanations on new content and contexts. The system also provides a communication network which students can use to collaborate in unraveling new learning. In situations where students' networks may not be adequate to fill the gap in knowledge, the students may involve teachers and experts. The speed of communication in the networked community facilitates the faster creation of new knowledge and learning, as theorized by Mok and Cheng (2001). The question that emerges is whether the learning in this environment is of a higher quality and whether its retention rate is higher. This would reflect in students' performance in formative assessment.

Studies have reported mixed results on the impact of the integration of ICT in teaching and learning. Some scholars reveal that teachers are overwhelmed with activities that relate to planning lessons that integrate ICT in education (Hayes, 2007; Benyard, Underwood & Twiner, 2006). In Australia for example, the teachers are challenged with the application of ICT in teaching and they spend more time adapting ICT into their traditional practices (Hayes, 2007). With this approach, the teachers have not realized any tangible benefits of ICT integration. Hayes (2007) recommends that teachers should be given technological support to change their pedagogical approaches before the impact of ICT integration may be felt. One theorized potential benefit of ICT in education is its multi-layered scaffolding capability (McLoughlin, 2002). ICT in education is resource-based and offers scaffolding through tasks, peer support and social interaction with the teacher as the agent (McLoughlin, 2002:155). Thus the impact of ICT in education may be fully realized when pedagogical approaches facilitate the optimization of these scaffolding layers. Livingstone (2011), in her critical reflection on the dearth of reported benefits of ICT in education, posits that educators have not embraced supportive pedagogies and that concrete definitions of benefits are lacking. Teachers explain their reluctance to adopt these pedagogies because of lack of skills (Neyland, 2011), inadequate resources, and a workload that leaves them with no time to prepare (Zakopoulos, 2005).

In Britain, **s**ome evaluation studies of Scholar and other ICT school projects have revealed the positive impact of these projects on student performance under certain conditions in a few subjects (European Schoolnet, 2006). Improvement has been reported in students' performances in the English language and science subjects after the prolonged integration of ICT in education. A much better performance, however, is reported in subjects that incorporate computer-aided instruction in schools in Britain and America (European Schoolnet, 2006; Infodev, 2005). At group level, the studies reveal that broadband access in classrooms results in significant improvement in pupils' performances in national tests and that schools with good ICT infrastructure and resources achieve better results than those with poor equipment. The availability of broadband in the classroom allows teachers to apply ICT in everyday classroom teaching. With the right ICT resources in the classroom, the teachers may direct students to engage with alternative learning resources, thus enabling them to explore additional learning materials that support their knowledge of content.

The application of ICT in education does not, however, show a positive impact on students' performance in mathematics in the case of British studies (European Schoolnet, 2006). This may be attributed to teachers' inability to develop learning tasks that may be supported by ICT use because the teachers are also competing with time to complete the curriculum and pushing students to attain better examination results (Hennessy, Ruthven & Brindley, 2005). However, an experiment in the Netherlands on the effects of digital intervention on algebraic expertise in secondary school students revealed an improvement in the students' performance in algebra (Bokhove & Drijvers, 2011). According to Bokhove and Drijvers (2011), factors that contributed to this improvement in performance include previous knowledge, pre-test results, the amount of time invested in digital self-tests, and the attitude towards mathematics. These findings indicate that ICT use in education has potential, as asserted by Voogt and Knezek (2008), but must be exploited with well aligned pedagogical approaches. However, it is important to note that Bokhove and Drijvers (2011) showed that the performance of students who were initially high performers in algebra declined at the end of the experiment. This finding further points to the dynamics of pedagogical approaches. In the intervention study, students had no opportunity to interact with peers, teachers and experts except at the conclusion of summative self-assessment. Computer aided instruction (CAI) or instruction software used in isolation negates the essence of ICT integration in education, as described by Mok and Cheng (2001). CAI should be part of the ICT infrastructure in blended learning so that the social network aspect of ICT integration is not removed from the learning processes. The pedagogies that may be successful are those that let students work on tasks on their own and at their pace, consistent with constructivist teaching. The challenges that should be addressed are those associated with the ICT skills of students, ICT and pedagogical skills of teachers, the quality of ICT resources, and the workload of the teachers.

3.7 Implications and lessons of reviewed literature on the current study – analytical review

The NEPAD e-School project is at a nascent stage of development compared to other e-School programmes in other parts of the world. It is being deployed in African countries where resources, particularly ICT resources, tend to be scarce. This calls for caution in the process, particularly with respect to identifying best practices in order to minimize the losses associated with uninformed experimentation. The review of literature on e-Schools in countries which have been implementing the system for many years is therefore considered useful in informing the implementation process of NEPAD e-Schools.

3.7.1 Influence of infrastructure on pedagogical practices

In the four countries discussed previously, ICT infrastructure is financed centrally by authorities in charge of education (Pearson, 2003; Sanchez & Salinas, 2008; Kozma, 2008; Indrus & Atan, 2004; Pandian, 2002; Watson, 2001). This is an indication that there is a unifying policy that is driving ICT integration in education in these countries. The availability of policy is important because it addresses salient issues on equity and the quality of infrastructure (Nachmias, Mioduser, Cohen, Tubin & Forkosh-Baruch, 2004). For example, the Chilean policy of developing ICT for education has been consistent for the last two decades, which has made it possible to improve ICT infrastructure in all government-supported schools countrywide. Nevertheless, when the policy is complex, as in the case of the UK's capacity building in blended learning (Younie, 2006), institutions with better networks and linkages may outperform their counterparts and create an intra-sectoral digital divide. It is therefore necessary to ensure inclusion by implementing policies that are harmonised across all levels of governance.

Studies in the four countries indicate an over reliance on computer laboratories as access points to ICT infrastructure (Hinostroza, Labbe, Brun & Matamala, 2011; Beacham, 2011). The computer laboratories are not only inadequate in number, but also not accessible after class hours. This frustrates the efforts of teachers in the pedagogical practice of integrating ICT in teaching and learning. Both teachers and students require unrestricted access to computing facilities in order to access e-resources and interact within the classroom and school and outside the school. Of the four countries, the United Kingdom recorded the highest computer to student ratio, approaching one student to one computer. Chile has made tremendous improvement achieving a ratio of 23 students to one computer. The Malaysian Smart School project is still at the pilot stage, with only 90 schools equipped with computing facilities in a few laboratories.

In Scotland, apart from computer laboratories, teachers have access to laptops that they can borrow to use by the students in the classrooms. This arrangement relieves pressure from computer laboratory scheduling but places added administrative responsibility on the teacher. The teachers need to do additional paperwork to oversee the borrowing of laptops, and also have to set up the system and dismantle and return the laptops after use (Beacham, 2011). Within the classrooms, Beacham (2011) observed that there was at least one computer connected to a data projector that was fixed to the ceiling. This arrangement, in the absence of borrowed laptops, forces teachers to use ICTs more as lesson presentation facilities than tools for enhancing pedagogical practices in the classrooms.

The above discussion would suggest that the ICT infrastructure in the e-Schools in most countries is not suitable for extensive integration in teaching and learning. The limitations with respect to access, systems management and user support structures, prohibit the exploitative use of e-Schools in the reviewed countries.

3.7.2 Influence of the teachers' workload on pedagogical practices

A teacher's workload is a contribution of national policy, teacher's discipline, and teaching and administrative responsibilities. In any educational system, the teacher is also a manager within the school, and in schools implementing ICT integration in teaching and learning, the teachers have three kinds of managerial duties: managing the activities in collaborative learning, such as timing and inviting less active members of the team to covert activities (Wang, 2008); managing the technical aspects of the learning tools (Beachan, 2011); and managing the functional division assigned by the employer or professional union (Ian, Brian, Olwen, Sheila and Tony, 2002; Sachs, 2001). The responsibilities of the teacher increase with the number of years of experience; the longer serving teachers are more likely to be assigned additional out of class responsibilities such as thematic group leadership (Day & Gu, 2007). Day and Gu (2007:436), in an analysis of longitudinal and multi-site data of teachers' ages and responsibilities in schools, established that up to 91% of teachers who had served in the profession for a period of 16 to 23 years had additional responsibilities outside the classroom, and the proportion decreased with the number of years of experience.

At any level, the teacher also manages students' issues relating to academic performance. In schools that practice the integration of ICT in teaching and learning, the activities relating to the development of new pedagogies and the professional development of teachers with respect to using and teaching information and communication technology may be considered as additional workload. Technology is advancing at a rapid rate, and some schools expect their teachers to at least attend short courses to keep up with technological developments (Boelens, 2010:250).

Partly in recognition of this challenge, most schools in Europe have resorted to employing part-time teachers (Boelens, 2010:45). The part time-teachers are young teachers who are more familiar with technology. In Britain for example, pre-service teachers are trained on pedagogical approaches to ICT integration. However, pedagogical skills in ICT integration should go hand in hand with a high level of teaching experience. Replacing the experienced teachers with these newly qualified teachers may deprive classroom practices of the tacit knowledge of longer serving teachers. The use of part-time teachers may alleviate the challenge of workload, which is a factor that very often dissuades teachers from remaining in their employment (Barmby, 2006:15), but it may also dilute the quality of curricula delivery. Educational authorities should consider bundling the professional development of experienced teachers with incentives that would make it difficult for the teachers to ignore continuous professional development. Teachers' engagement in professional development and therefore lifelong learning is also a way of mentoring their students (Day & Gu, 2007). When students see their teachers engaging in private studies, the students inculcate lifelong learning habits too.

Heavy workloads are a source of stress for teachers, and coupled with their low computer self-efficacy, teachers in most e-Schools find themselves unable to exploitatively integrate ICT in teaching and learning. With so much work to be done, the teachers do not have adequate time to consult with more knowledgeable peers in planning lessons that effectively integrate ICT in the teaching and learning process.

3.7.3 Implication of evaluation models on reported performances of ICT integration initiatives

The studies that have informed this chapter have used various approaches to evaluate the performance of ICT integration in teaching and learning. Twenty one journal articles were reviewed. The main approaches used in these studies, in order of decreasing frequency of use, were: survey, case study, literature review, meta-analysis, and action research. A distinction is made between meta-analysis and the literature review. In this discussion, meta-analysis has been reserved to mean the analysis of data derived from existing literature. Table 3.1 shows the list of publications with the corresponding evaluation methodologies, and Table 3.2 shows the distribution of the methodologies of evaluation.

Table 3.1: Evaluation model adopted in each publication

Country	Study Design	Underpinning Theory	Author (s)
Australia	Case studies involving observation and interviews	N/A	Hayes, D. N. A. (2003)
	Survey	N/A	Neyland, E. (2007)
	Survey	N/A	Baskin, C. and Williams, M. (2006)
	Survey	N/A	Janieson-Proctor, R. M., Burnett, P. C., Finger, G. & Watson, G. (2006)
	Survey	N/A	Bates, F. (2010)
Chile	Documentary analysis	N/A	Sanchez, J. & Salinas, A. (2008)
	Survey	N/A	Hinostroza, J. E., Labbe, C., Brun, M. & Matamala, C. (2011)
	Survey	Transformability, Participation, 5 Cs of digital inclusion	Beacham, N. (2011)
	Synthesis	N/A	Kozma, R. B. (2008)
	Case study using interviews, observations and focus group discussions	N/A	Light, D. (2009)
Malaysia	Case study	N/A	Indrus, R. M. and Atan, H. (2004)
	Focus Group Discussions	Grounded theory	Hamzah, M. I., Ismail, A. and Embi, M. A. (2009)
	Survey	N/A	Bakar, R. and Mohamed, S. (2008)
	Survey	N/A	Ah-Choo, K. (2008)
United Kingdom	Literature review	N/A	Mee, A. (2007)
	Meta-analysis	N/A	Machin, S., McNally, S. and Silva, O. (2007)
	Literature review	N/A	Younie, S. (2006)
	Survey	N/A	Condie, R. and Livingston, K. (2007)
	Meta analysis	Multi-level framework	Davis, N. E., Preston, C. and Sahin, I. (2009)
	Case study and action research	N/A	Deaney, R. Ruthven, K. and Hennessy, S. (2006)

Table 3.2: Distribution of evaluation methodologies

Evaluation methodology	**Frequency**	**Percentage**
Survey	9	42.9
Case Study	5	23.8
Literature review	4	19.0
Meta analysis	2	9.5
Action research	1	4.8
Total	21	100

From Table 3.2, it is evident that the most frequently used evaluation approach is survey methodology. Survey methodology can take on a variety of forms. It is mostly used when the population is large and the study aims to make inferences. A striking revelation in Table 3.1 is that hardly any of the evaluation studies of ICT integration in curricula were based on a theory. Only three studies were underpinned by a theory, and the theories used are not commonly applied in the evaluation of ICT integration. This makes it difficult to compare the outcomes of the studies.

Petter, DeLone, and McLean (2008) recommend that information systems' evaluation studies should be underpinned by one theoretical framework and should use validated instruments as a way of making the outcomes of the studies comparable. Even though a sizeable proportion (48%) of the studies reviewed in this paper were published in 2008 or later, none of them had adopted this recommendation by Petter, DeLone, and McLean (2008). Furthermore, none of the 21 studies shared an evaluation instrument, further complicating any attempt to compare their results. The wide spectrum of evaluation methodologies and tools applied in these studies may be a contributing factor to the lack of convergence of the results. Nevertheless, the academic rigour of the studies makes their findings acceptable in academic discourse.

3.8 Summary

This chapter has provided a critical review of literature. Literature on the progress of ICT integration in education delivery was reviewed, with a case study of the well published efforts of four countries in integrating ICT in curricula through various projects. Specific attention was given to the diffusion of ICT infrastructure, the ICT literacy levels of users, influence of the exploitative use of the e-Schools, and the benefits of the e-Schools. It was assumed that ICT integration facilitates the use of computing devices such as desktop computers, laptops, handheld computers, software, or the internet for instructional purposes, particularly collaborative learning between peers facilitated by online communication. However in the project review of the four countries, it was established that ICT infrastructure is largely used as a tool for teaching presentation. This has also been established in other countries, for example in Flanders (Tondeur, Van Braak & Valcke, 2007) and the U.S.A. (Hew & Brush, 2007), and shows that there is a gap between practice and policy.

The major challenges affecting ICT integration in teaching and learning identified here were the diffusion of ICT infrastructure and the professional endowment of teachers with both technical and pedagogical skills. Through synthesis, it was established that the diffusion of ICT, professional culture, and high student to teacher ratio, negatively impact on teachers' efforts towards adopting student-centered pedagogies appropriate for ICT integration in teaching and learning. It also became evident that studies on the evaluation of performances of ICT integration in curricula delivery initiatives do not share evaluation approaches and instruments. This makes it difficult to compare the outcome of the evaluations, as posited by Petter, DeLone, and McLean (2008).

It remains unclear whether, by underpinning the evaluations on the same theoretical framework and using similar instruments, the studies' outcomes would converge to the evidence of the positive influence of ICT integration in teaching and learning. Further studies should be conducted in different countries and contexts with a view to replicating the findings to fill this gap in knowledge.

CHAPTER FOUR

METHODOLOGY

4.1 Introduction

The aim of this study was to evaluate the success of NEPAD's pilot e-School project in Kenya using an adapted version of DeLone and McLean's (2003) IS Success Model. In order to achieve this, it was necessary to underscore the systematic nature of research and outline the approach or methodology (McNabb, 2010) that facilitated the comprehensive collection and treatment of information from stakeholders in NEPAD's e-School demo project. According to Gratton and Jones (2004), research is a systematic process of discovery and advancement of human knowledge. This concurs with Kothari's (2004) definition of research as a scientific and systematic search for pertinent information on a specific topic. This chapter systematically discusses the research methodology and methods used in the study. Specifically, Chapter four discusses the study population, research design, data collection instruments, administration of these instruments, data analysis, and the challenges encountered during data collection.

4.2 Study population

The decision about the population of a study determines the methodology and methods used in the study (Rabbie, 2010). The flipside is that what constitutes the population depends on the goal of the study (Montello & Sutton, 2006). This study sought to determine the level of success (or vice versa) of NEPAD's pilot e-School project. The focus was specifically on the installed e-School systems that have been used in NEPAD's pilot e-Schools. In Kenya, six secondary schools are currently participating in the pilot. The six schools are distributed across six regions in the country and were selected by NEPAD as follows: Maranda High School in the Nyanza region; Chevakali High School in the western region; Menengai High School in Rift Valley Province; Isiolo Girls Secondary School in the eastern region; Mumbi Girls Secondary School in Central Province; and Wajir Girls Secondary School in the north eastern region. Location-wise, the schools are very far from each other. With Nairobi as a point of reference, the nearest school (Mumbi Girls Secondary) is 77 kilometres away, while the furthest school (Wajir Girls High School) is 687 kilometres away.

The schools are considered units in the study because variables with respect to installed ICT infrastructure varied from one school to next.

The study investigated several aspects/dimensions of the e-School system, some of which required the perceptions of e-School system users. The seven dimensions investigated in the study were: (i) Infrastructure quality, (ii) Content and communication quality, (iii) Service quality, (iv) Training effectiveness, (v) Use, (vi) Teachers' and learners' satisfaction, and (vii) Net benefits. Invariably, students and teachers interacting with the e-School systems qualified as a population group of the study. Both male and female students attend the schools in question. However, only one of the six schools, Menengai High School, enrolls both genders. Chevakali and Maranda High Schools are male only schools, while Isiolo, Mumbi and Wajir Secondary Schools are female only schools. Each of the six schools had students enrolled in forms one, two, three and four (9, 10, 11 and 12 years of education). The number of students enrolled varied from one school to the next but was determined partly by the number of class streams established in the school, which ranged from two to five. Both male and female teachers were employed in the schools. The population of teachers in the schools was directly proportional to the student population, averaging at 5.5% of the student population. There were no guidelines that restricted the distribution of male and female teachers in a school. However, the population of female teachers was high in schools close to towns, and very low in schools in the perceived hardship areas (eastern and north eastern regions). Table 4.1 shows the distribution of students in the six schools, while Table 4.2 shows the distribution of teachers.

Table 4.1: Student distribution in the e-Schools

	Form One		Form Two		Form Three		Form Four		Total	
Gender	F	M	F	M	F	M	F	M	F	M
Chevakali High School	0	346	0	293	0	230	0	229	0	1098
Isiolo Girls Secondary School	70	0	130	0	125	0	105	0	430	0
Maranda High School		425	0	325	0	270	0	242	0	1262
Menengai High School	111	188	75	186	82	155	100	160	368	689
Mumbi Girls Secondary School	130	0	141	0	174	0	137	0	582	0
Wajir Girls High School	156	0	130	0	145	0	76	0	507	0
Total	467	959	476	804	526	655	418	631	1887	3049
Grand Total										4936

Table 4.2: Teacher distribution in the e-Schools

School	No. Of Female Teachers	No. Of Male Teachers	Total
Chevakali High School	21	38	59
Isiolo Girls Secondary School	8	15	23
Maranda High School	10	48	58
Menengai High School	31	24	55
Mumbi Girls Secondary School	17	11	28
Wajir Girls High School	6	21	27
Total	93	157	250

4.3 Study sample

Wesley and McEntarffer (2010) explain that to conduct a survey, one must first identify the population from which the sample will be drawn. Sampling is a technique used with a large study population in order to minimize cost, accelerate the speed of data collection, and assure that what applies in the case of the sample will also hold true in the larger population; in other words achieving efficiency in obtaining accurate information (Deming, 1966; Johnson & Christensen, 2010). The most effective sampling procedure is random sampling, which tends to provide a highly representative sample of the population from which it is derived (Wesley & McEntarffer, 2010). Random sampling is achieved by selecting respondents using theories of probability. Using this technique, every respondent has an equal chance of being included in the sample.

4.3.1 Determining sample size

This study used both purposive and random sampling. Purposive sampling was used in order to select the e-Schools. The six NEPAD e-Schools were all included in the study to assure complete coverage of e-School implementation in the country. Although the schools were distributed in six administrative regions (provinces), which made it expensive in terms of time and travel, the benefits of assessing the variables with more data outweighed the costs. The total number of students in the six schools was 4,936, while the number of teachers was 250. Stratified probabilistic sampling based on students' population in the different e-Schools and gender distribution within the mixed gender school, was done to make the data collection cost effective and achieve results that could be inferred on the population through inductive reasoning (Guerrero, 2010).

Necessary steps were taken to reduce sampling error in the study. In particular, an acceptably large sample was sought and the variability of the sample characteristics was increased by using stratification within and between schools (Hussmann, Mehran & Varma, 1990). The study also took into consideration that the data was to be split into two halves to achieve exploratory and confirmatory factor analysis. Furthermore, the responses were to be spread across four levels of education (forms I, II, III and IV). Lastly, each dimension of e-School success was to be assessed using many question items. Blaikie (2009) observes that when so many conditions have to be satisfied, the sample size should be made larger. With the average degree of freedom of 8 for each dimension, a power of alpha = 0.8, and the level of confidence of 0.05 set for this study, the minimum sample size, according to MacCallum, Browne and Sugawara (1996), is 754 (see Table 4.3), which comprises 15.27% of the study population. To increase the representativeness of the sample and to accommodate the use of split halves in undertaking exploratory factor analysis, the sample size determined by MacCallum and Sugawara's (1996) calculations was doubled to 1508 respondents.

Table 4.3: Minimum sample sizes for test of exact fit for selected levels of Degrees of Freedom (df) and Power

Df	Minimum *N* for power = 0.80	Minimum *N* for power = 0.50	*Df*	Minimum *N* for power = 0.80	Minimum *N* for power = 0.50
2	1,926	994	35	300	180
4	1,194	644	40	277	167
6	910	502	45	258	157
8	754	422	50	243	148
10	651	369	55	230	140
12	579	332	60	218	134
14	525	304	65	209	128
16	483	280	70	200	123
18	449	262	75	193	119
20	421	247	80	186	115
25	368	218	85	179	111
30	329	196	90	174	108
			95	168	105
			100	164	102

Note: a = .05, e, = 0.0, and e_a = 0.05, where e, is the null value of the root-mean-square error of approximation (RMSEA) and e is the alternative value of RMSEA

Adapted from MacCallum, Browne and Sugawara (1996)

4.3.2 Sampling procedure

In order to come up with the sample, ICT champions in each NEPAD e-School were first contacted through the schools' principals. ICT champions are the group of teachers who were trained by the Kenyan Chapter of the NEPAD e-Africa Commission on ICT skills to maintain the e-Schools, induct teachers and students in the use of e-Schools, and to advocate for adoption of these schools. The schools' principals put the researcher in touch with each school's ICT champion. Thereafter, e-mail communication was established. Each ICT champion assisted with securing class attendance registers and the list of teachers employed in the NEPAD e-Schools. These documents constituted the sample frame for the study. The education levels (forms I to IV) were used as a sub-frame for stratification. In Menengai High School, stratification was done according to both educational level and gender. Therefore, explicit strata were generated based on the number of students registered in each grade/form and the proportion of females and males in that grade/form (Wright & Marsden, 2010). In the case of teachers using the e-School system, simple random sampling was used to identify the respondents. The teachers' listing was inserted into an Excel sheet. Using the Excel function =RANDBETWEEN (1-250), a group of random numbers were assigned to the teachers. These random numbers were used to sort out the teachers list in ascending order. The first 90 teachers in the final list were included in the sample. The final sample for the study population is shown in Table 4.4 and Table 4.5**.**

Table 4.4: Sample of students

School	Percentage Composition		Stratified Sample		Total Sample
Gender	F	M	F	M	
Chevakali High School	0	22	0	314	314
Isiolo Girls Secondary School	9	0	119	0	119
Maranda High School	0	26	0	371	371
Menengai High School	7	14	100	200	300
Mumbi Girls Secondary School	12	0	171	0	171
Wajir Girls High School	10	0	143	0	143
Total	38	62	533	885	1418

Table 4.5: Sample of teachers

School	**Total**	**Sample Size**
Chevakali High School	59	18
Isiolo Girls Secondary School	23	10
Maranda High School	58	21
Menengai High School	55	17
Mumbi Girls Secondary School	28	13
Wajir Girls High School	27	11
Total	250	90

4.4 Research design and methodologies

The study sample was relatively large and the respondents were geographically dispersed over a wide area. To optimizes the use of resources while assuring quality output, the study had to be articulately designed. As with any other study, the scope of research design encompasses the identification and development of all the procedures and logistical arrangements that are necessary to undertake a study (Kumar, 2010). Research design also embeds quality in the procedures in order to assure validity, objectivity and accuracy. It should therefore follow a framework that is grounded in literature and that makes it easier for the scientific community to understand the study (Creswell, 2003). Kerlinger (1986) provides a concise definition of research design as a plan, structure and strategy of investigation that is conceived in order to obtain answers to research questions or problems. As a plan, research design provides a complete outline of what the investigator will do, from writing the research hypotheses and their operational implications, to the final analysis of data (Kerlinger, 1986:279). Hall (2008) defines research design as all plans, including methods and procedures, for data collection.

According to Hall (2008) there isn't one ideal method because every method has benefits and pitfalls. Factors that influence the choice of the research method include the level of desired validity of the results, time frame of the study, cost constraints, type of questions, and the research setting (Johnson & Christensen, 2010; Hall, 2008). The way of thinking about and conducting research is also referred to as a paradigm (Kuhn, 1970; Gliner & Morgan, 2009). Research paradigms in the scientific community have shifted over the years, but three strands are recognizable: positivist, interpretive and middle ground.

Positivists believe that there exists a reality which can be found by disintegrating a phenomenon into variables through which the behaviour of the phenomenon can be analysed. This is also referred to as realist ontological assumptions (Stahl, 2008). Positivists assert that reality is independent of the investigator and is domicile in the collected data (Johnson & Onwuegbuzie, 2004; Amaratunga, Baldry, Sarshar & Newton, 2002). Anti-positivists, on the other hand, assert that the observer's mind must be involved in the constitution of reality and therefore research is a subjective activity (Stahl, 2008). Members of this community are called interpretivists. Interpretivism holds that reality is a social construct arising from communicative action. Understanding some aspects of e-School evaluation requires testing that is independent of the researcher while other aspects require the researcher's active interpretation. This made it necessary to consider the application of both positivist and interpretive paradigms.

The combination of different paradigms is not a new phenomenon. Over time, the scientific community has come to appreciate that either paradigm can make contributions to a study. Sticking to a single paradigm may, however, systematically preclude less salient issues, making the option of applying different paradigms in combination convincing (Choudrie & Dwivedi, 2005). The combination of the different paradigms applied in this study is referred to as a middle ground paradigm. It was used to enable the investigator to triangulate findings from different sources to improve quality, validity and reliability in the study (Shreve & Angelone, 2010). With this decision, the investigator employed more than one methodological approach for data collection (observations, interviews and questionnaires). It was believed that the different methods would converge to produce the same results that then serve to enhance the validity of the research (Hesse-Biber & Leavy, 2011). The procedure of analysing data from different sources is referred to as triangulation. Triangulation may be undertaken from a theoretical perspective (the study uses more than one theory) or from a methodological perspective (Oates, 2006). This study relied on methodological triangulation that was expected to facilitate the realization of a more complex model. Methodological triangulation is believed to enrich data analysis (Carter and New, 2004). The middle ground paradigm essentially has each of the two paradigms (positivist and interpretive) active within it. It therefore allows the use of distinct methodologies of data collection, generally divided into qualitative and quantitative methodologies (Choudrie & Dwivedi, 2005), simultaneously within the same study. The evaluation of e-School success required the collection of qualitative data which facilitates the exploration of attitudes, behaviour and experiences. At the same time, it required quantitative data for verification, testing and ascertaining causal effects (Dawson, 2002). The combination of quantitative data that deals mainly with numbers, and qualitative data that deals mainly with meaning that is mediated through language and action (Dey, 2005), was found useful in validating the E-School Success Model.

The evaluation of the success of NEPAD's pilot e-Schools required collection of data from variety of sources. The information included the observation of installed infrastructure, opinion of e-School principles, and the perceptions of e-School users on different dimensions of the e-School system. Data collection was planned to take place over two months. This therefore required a methodology that allows the mixing of data collection techniques that would accelerate the process. The study therefore used the survey research methodology as it is effective in rapid data collection and facilitates the mixing of methods (Johnson & Christensen, 2010). The survey, like any other methodology, requires a well articulated design to guide the entire process of data collection, analysis and reporting.

4.4.1 Survey research methodology

In evaluating the success of the NEPAD e-School, the target population was definable: the e-Schools themselves and the users of the e-Schools. The users were students and teachers in the schools participating in NEPAD's pilot e-Schools. The e-School users had varied perceptions about the different dimensions of the e-School and had different experiences with the ICT infrastructure of the e-Schools. These perceptions and experiences were defined into variables (operationalised**)** to make them measurable. As a result, it was possible to describe the situation and perceptions of the e-School users within each dimension. The e-School itself was also amenable to description in terms of the quality of the infrastructure and installed software. The target population was accessible and reduced to a representative sample to make it possible for the study to be completed in time and to reduce the cost of data analysis while still retaining reliability. An estimate of the sample parameters was made to facilitate inference on the target population usually acceptable in survey research method (Biemer & Lyberg, 2003).

The survey method is highly scientific, applying principles of traditional academic disciplines such as mathematics. Borrowing from mathematics, a survey applies the principles of probability or chance events in determining the frequency of various outcomes (Groves, Fowler, Couper, Lepkowski & Singer, 2009). It employs statistics in sampling and inference from sample results onto the target population. Surveys also borrow heavily from the social sciences, such as computer science which offers principles of computer-human interaction.

4.4.2 Data collection instruments

The survey method is a popular choice for data collection because it can use a variety of data collection techniques which facilitate data triangulation (Johnson & Christensen, 2010). When implementing the survey method, data may be collected using a variety of tools including observation schedules, interview schedules, questionnaires, and focus group discussions. In selecting the method of data collection, this considered, among other issues, the ease with which the respondents were to be identified, characteristics of the respondents, the complexity and sensitivity of the desired survey data, and generally speaking, the perceived optimal method of data collection (Van Horn & Monsen, 2008). The current study triangulated data using an observation schedule, interview schedule, and questionnaires, which are considered very handy tools for the systematic recording of information (Gupta, 2007). Each of the data collection instrument served a specific purpose, as discussed in the sub-sections that follow.

4.4.2.1 The observation schedule

Field observation in different locations should be standardized using a structured observation schedule. A structured observation schedule is used to focus on designated aspects of behaviour or environmental conditions so that data collection is restricted to only what is necessary (Bachiochi & Weiner, 2002). Some aspects of the installed e-School systems could be recorded using the reports of informants while others were observable. The researcher had to determine what was observable well before the observation could start (Foster, 1996). Observations focused on the condition of the roads leading to e-Schools, availability of electricity for powering the e-School system, and the condition of classrooms and computer laboratories and the installed ICT infrastructure. The condition of the access road to the e-School has an impact on the cost of infrastructure installation and maintenance. Very poor roads may influence the mode of transporting sensitive ICT equipment such as servers, and also influence maintenance contract costs quoted by service providers.

The observation schedule was limited to thirteen points: grade of the road, number of installed computers, location of computers (laboratories or classrooms), network configuration, availability of the internet, availability of printing services, access to the e-School from surrounds or by the neighbouring community, and nature of use by the community. Some of these observations were done in an attempt to corroborate statements that were gathered from school principals using the interview schedule (Ramanathan, 2009). The points included in the observation schedule were informed by a literature review on ICT integration in the curriculum and the objectives of the NEPAD e-School project. These observation points could be collapsed into installed e-School infrastructure, and levels of access to, and use of the infrastructure.

4.4.2.2 The interview schedule

A survey may be used to collect in-depth information. This is normally achieved through follow-up questions which are based on a literature review, or the analysis of data gathered through questionnaires or presented in-person. The researcher prepared a list of issues for discussion with the principals of the e-Schools or their representatives. Only one interview was conducted for each e-School in order to save time and reduce expenses (Engel & Schutt, 2005). The interview schedule implemented in this study was designed for top management in the e-School - either the head of the school, or senior staff members who were familiar with or had access to implementation records of the e-School system (Groves, Fowler, Couper, Lepkowski & Singer, 2009).

Interviews in a survey are one-on-one question and answer sessions between individuals, and can therefore be influenced by the natural social behavior of people. The behaviour of interviewers may influence interviewees' responses to the questions through what researchers believe are 'interviewer expectations' or through the failure of the interviewer to probe the interviewee during the questioning stage (Groves, 2004). Such interferences with data collection are difficult to measure, but their effects are normally grouped under measurement error. Groves, Fowler, Couper, Lepkowski and Singer (2009) define measurement error as a departure from the true value of the measurement as applied to a sample unit and the value provided. Controlling some of these errors may be achieved by controlling the behaviours of interviewers (Groves, 2004). In this study, control of interviewers' behaviours was achieved through standardization of conduct by enlightening the research assistants on the consequences of their conduct during interview sessions. The interviewers were trained on how to pose questions and limit further questions to only those instances where the response was inadequate (Conrad & Schober, 2008). This is because it is believed that more probing tends to increase variability in the context of the question.

A closely related source of measurement error is the wording in a questionnaire or an interview schedule (Iarossi, 2006). Certain words easily strike a chord in respondents, particularly if the word appears to tilt the nature of response in favour of the respondent. Given the option, respondents tend to provide answers that make them sound pleasant to the interviewer or respond in a way that they perceive as defending their integrity. Wording and language in a questionnaire should be precise to reduce associated measurement error (Groves, 2004). The planning of a survey should therefore be well articulated and implementation should go according to a plan to improve the reliability of results. The design of the survey should provide a window period for eliminating potential problems that would reduce reliability (Biemer & Lyberg, 2003).

The interview schedule consisted of ten questions with room for further probing in the case of some of the questions. Interviewees were also questioned further when they restricted their answers or appeared not to provide specific answers (Robin & Robin, 2005; Gilmore & Campbell, 2005). Some interviewees generally tend to be passive during the interview process. Research assistants were therefore first briefed on interview techniques, such as how to place interviewees in their comfort zones by creating rapport on the first encounter in an attempt to encourage the interviewees to provide more genuine responses (Amedeo, Golledge & Stimson, 2009; Conrad & Schober, 2008).

The interview schedule sought information from interviewees on persons or organizations that maintain the e-School system, the suppliers of consumables, the number of teachers who were trained in the use and integration of ICT in the curriculum, and how the training of students on the use of the e-School system was organized. Other areas investigated were unresolved issues in the running of the e-Schools, improvements necessary in the infrastructure, the likelihood of achieving the objectives of the NEPAD e-School project, and how the level of success of the project could be improved. Furthermore, the interviewees were asked to give their opinions on how the e-Schools' academic performance had changed between 2006 when the e-School system was installed and the present. While the questions were standardized, probing could not be standardized because the investigator had no control over the interviewees' responses. However, by using only two research assistants, variability in the context of probing was reduced.

4.4.2.3 The questionnaire

Most of the data for this study was collected using the questionnaire. This is because it can collect data from a large sample of respondents within a relatively short period of time (du Plooy, 2008). Other advantages of the questionnaire include the low cost of implementation, freedom of the respondent to choose when to complete the questionnaire, and the variety of ways it can be administered. In the information age, the internet provides a very rapid way of administering questionnaires. Webmonkey in particular has gained popularity in marketing the research and surveys of institutions at both national and international level (Joseph, 2006). This study could not implement Webmonkey because students and teachers did not have access to the internet, contrary to expectations raised through the literature review of the NEPAD e-School system.

The questionnaire could not be mailed to the schools because there were doubts about the commitment of the ICT champions to coordinate the students and teachers. Secondly, the ICT champions were themselves respondents and it would not have been prudent to involve them in the facilitation. The questionnaire was therefore hand-delivered to the schools by the research assistants, who were also required to observe the installed infrastructure and conduct interviews. The hand-delivery of questionnaires is known to be very effective in improving the response rate, sometimes by as much as 80% (Maxfield and Babbie, 2008). In the documented cases of hand-delivery, a research assistant delivers the questionnaire to the sampled respondents, explains the goals of the study, then leaves the questionnaire with the respondent to answer with the aim of collecting the completed questionnaire at a later date (Kirby, Greaves and Reid, 2006). While they were delivering the questionnaires, the research assistants simultaneously booked appointments with the principals of the schools to arrange interviews. The date of the interview was made to coincide with the date of questionnaire collection to save time and reduce travelling expenses.

The questionnaire was organized into two sections. The first section captured the particulars of the respondent, specifically their school, gender, role in the school (i.e. teacher or student), and class (if student). All the question items in this section had answer options because they could be pre-determined. In this approach, exhaustive listing of optional answers was provided to reduce chances of responses being in favour of a particular direction in the provided answers (McIlwraith, 2006). For example, in the section of respondents' particulars, the name of the schools and the students' levels of study (forms I, II, III, IV) were definite so it was easy to list them. The inclusion of gender as a question item was mainly to make a distinction in the genders of teachers and students in Menengai High School which enrols both genders. Overall, the questionnaire was designed to first solicit personal information before asking in-depth questions as a way of calming the respondents and motivating them to answer subsequent questions (Cargan, 2007).

The second section of the questionnaire presented the respondents with questions grouped according to the different aspects/dimensions of the e-School. The first aspect was the infrastructure quality of the e-School system. It was thought that every user would be concerned about the quality of the infrastructure and interested in answering related questions without hesitation. All the measurement tools for each dimension consisted of both close-ended and open-ended questions. Close-ended questions were presented first for the same reason of enticing respondents to engage with the survey. Close-ended questions were structured on a Likert-scale of four points throughout. The four points represented the level of agreement or disagreement with the statement posed: 1 – strongly disagree, 2 – disagree, 3 – agree, and 4 – strongly agree.

The Likert-scale is a widely used psychometric scale in questionnaires for measuring respondents' level of agreement with statements (Keeney, McKenna, & Hasson, 2011). The most popular type of Likert measure is on a scale of 1 - 5. The middle scale, however, gives the respondent a neutral position which states neither agreement nor disagreement with the statement. This study eliminated neutrality to condition the respondents to either agree or disagree with different statements (Giles, 2002). One of the advantages of the Likert-scale is that it gives all the measurements equal weight (Keeney, McKenna, & Hasson, 2011). This was desired in this study because it made it easier to compare the level of success of each e-School. The open-ended questions were limited but enough to collect additional information which could not be predetermined through the literature review. They were also intended to make the respondents feel valued because they had the opportunity to express their thoughts and feelings in their own words instead of using words chosen for them by the investigator (Weisber, Krosnic & Bowen, 1996).

4.5 Pilot study

In order to test the three data collection instruments, a less formal field observation known as a pilot study was conducted prior to the main study (Hughes, 2009). A pilot study reveals to the investigator pertinent issues that will be encountered during the full implementation of the research instrument. For planning purposes, a pilot study also provides an indication of how long the study will take (Thomas, Nelson & Silverman, 2010). This information was useful with respect to budgeting and the schedule for writing the report. The pilot study played a key role in refining the data collection instruments. The responses in the pilot study also showed the respondents' capacity to answer the questions (McNabb, 2010). Responses to the question items in the pilot study were subject to item analysis to determine whether they were clear to the respondents and whether they measured what they were intended to measure (Thomas, Nelson & Silverman, 2010). Very few question items were found to be ambiguous and were edited for more clarity to the respondents.

4.5.1 Contact setting

Mumbi Girls Secondary School was identified as the most convenient site for the pilot study. It was the nearest study site, situated some 77 kilometres from Nairobi, the control base of the field study. Other study sites were far away, ranging from 157 kilometres (Nakuru), to 687 kilometres (Wajir) from Nairobi. To initiate contact with the school, the researcher travelled to Muranga, the nearest administrative office to the school, to seek permission from the District Education Officer. There was no difficulty in convincing the District Education Officer because a research permit had already been secured from the Ministry of Higher Education, Science and Technology. The letter from the District Education Officer, together with the research permit, was used as proof that the study was recognized by the government of Kenya. The principal of the school therefore accepted an appointment for an interview and also authorized the survey of students and teachers.

4.5.2 The questionnaire

All three data collection instruments were administered during the pilot. 20 questionnaires were left with the ICT champion at each school to distribute to students and teachers. The completed questionnaires were collected from the ICT champion three days later. A total of 17 questionnaires were completed (4 teachers and 13 students). The data collected from the pilot was then subject to item analysis. All the respondents selected answers from the options where required, and the majority filled in the open-ended questions. Data collected using the questionnaire was entered into SPSS, and the correlation between the items and dimensions came to 0.6, which is higher than the minimum 0.4 allowed for exploratory studies. The items were therefore measuring what they were intended to measure.

Further scrutiny of the questionnaire revealed that the section on personal information required improvement in item numbering and giving students the option to indicate their form (year of education). Although the section on information content and communication quality was well responded to, the nine question items were found to be inadequate. The number of question items was therefore increased to twelve, partly to capture the possible existence of communication between students in different NEPAD e-Schools. The section on service quality was not well understood in the pilot. An additional introduction was added before the question items in this section.

4.5.3 The interview schedule

The interview schedule was administered with the principal as the interviewee. The structured questions in the interview were arranged to facilitate flow during discussion. With the full cooperation of the principal and because the schedule had been made short in anticipation of the interviewee's commitments, no changes to the content were necessary. The experience was shared with the research assistants during their training.

4.5.4 The observation schedule

The researcher took note of physical facilities, beginning with the road leading to the school and visible network and computer installations. It occurred to the researcher that taking photographs of useful physical facilities would make it possible for the researcher to compare the infrastructure in the different schools during data analysis. This was especially the case because the researcher did not envisage travelling to all the e-Schools in person. The research assistants were expected to collect data from some e-Schools while the researcher collected data from other e-Schools. The requirement to take photographs of installed infrastructure was subsequently shared with the research assistants.

4.6 Administration of the research instruments

One round trip to the six schools using the shortest road distance comes to 2, 285 kilometres. If data collection was to be made by one person, the shortest route would have been Nairobi to Nakuru, Nakuru to Bondo, Bondo to Kakamega, Kakamega to Wajir, Wajir to Garissa, Garissa to Isiolo, Isiolo to Muranga, and Muranga to Nairobi. However, three persons participated in data collection. The routes taken by each research assistant and the researcher was informed by the shortest distance based on distances between e-Schools as shown in Table 4.6.

Table 4.6: Road distance between study sites

Reference Site	Destination	Road Distance
Nairobi	Nakuru	157
Nakuru	Bondo	255
Bondo	Kakamega	104
Kakamega	Garissa	750
Garissa	Wajir	320
Garissa	Isiolo	424
Isiolo	Muranga	198
Muranga	Nairobi	77
Total		2,285

Figure 4.1 is a map of Kenya showing the locations of NEPAD e-Schools in Kenya

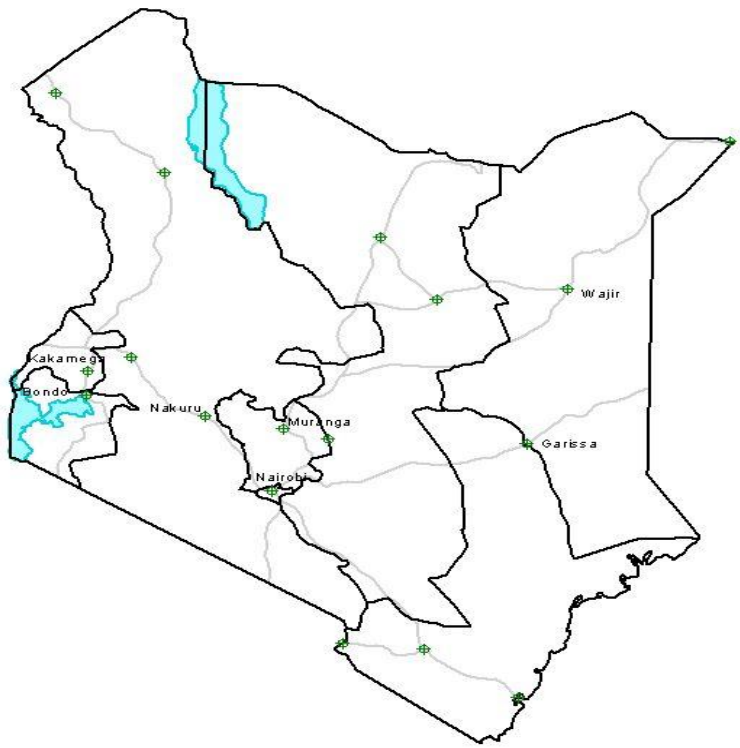

Figure 4.1: Map of locations of NEPAD e-Schools

Arrangements were made for the research assistants to meet the ICT champions at their workplaces to confirm that the students listed in the sample were actually in school based on the latest class attendance registers. They also agreed to remind the principals of the schools about the appointments which had been made to facilitate interviews.

4.7 Administration of the observation schedule

The observation was conducted by each research assistant on arrival at the school. Observation started from the point the 'unclassified' road leading to the school branches off from the classified road. The roads' conditions were recorded as tarmac, all-weather, or unmaintained path. Within the e-School, photographs were taken of the ICT equipment installed inside and outside the laboratories. Important infrastructure included the Very Small Aperture Terminal (VSAT) used for linking LANs to the satellite, arrangement of the computers installed in a laboratory, evidence of data switching terminals, evidence of smart screens, and evidence of cable networks. A count was also made of the number of computer laboratories and the number of computers and printers installed in each computer laboratory. The research assistants were also requested to observe the use of infrastructure by students and teachers. However, quantitative measurement of use was not possible due to limitations in the audit trail in the servers and the long time it would take to manually observe the length of time each of the students was using e-School facilities.

4.7.1 Administration of the interview schedule

For each e-School, only the headmaster or headmistress was interviewed. Interviews were done either during the first visit if the head of the school had consented to the appointment telephonically, or on the day set for collecting the completed questionnaires. Each interview session was timed to last not more than 45 minutes to avoid situations where the interviewees lost concentration or were forced to abandon the interview for other engagements. Stoop (2005) argues that some respondents weigh the time spent answering survey questions against forgone opportunities. Heads of schools tend to be busy with a constant stream of teachers, students and parents into their offices. Bednar and Westphal (2006) established that the length of interviews significantly affects the response rate. Their findings, however, showed that the quality of the interview response is not significantly influenced by the length of an interview. In this study, the interviews were kept short to encourage the heads of schools to participate and to avoid distraction from visitors demanding to see them. Such distractions were eminent as the interviews were conducted in November 2011, when national examinations were in progress.

During interviews, rapport was achieved through a formal introduction, making positive comments about the school, and appreciating the challenges the principal of the school could be experiencing. According to Holbrook, Green and Krosnick (2003), rapport helps to reduce instances of respondents giving socially acceptable answers instead of responding truthfully to the interview questions. The authorization that the research assistants presented from the government offices also assured the schools' principals that the data collected would not be used unethically, which encouraged them to speak freely when answering the questions.

4.7.2 Administration of the questionnaire

The design of the questionnaire was strategic to make it easier and faster to complete. It consisted of a total of 87 question items - 73 (84%) close-ended and 14 (16%) open-ended questions. Extant literature confirms that respondents are more receptive to close-ended question items. Open-ended questions are more taxing to the respondent because the respondent has to write a statement or offer his/her opinion in order to provide an answer (Ruane, 2005). As a result, open-ended questions tend to suffer a lower response rate (Ruane, 2005:132). The response rate for open questions becomes much lower when respondents are not fluent in the language of communication. This was anticipated in the e-Schools because respondents varied from teachers, to form one (9^{th} year of education) and form four (12^{th} year of education) students. Form one is the level at which all communication in the classroom in Kenya switches to English (Schmied, 2004), and therefore some respondents from this level of education were expected to experience difficulty in answering the open-ended questions. To overcome these challenges, the open-ended questions were made brief, with very simple use of the English language. The statements solicited through these questions were lists that required very short narratives.

The research assistants confirmed the accuracy of samples by crosschecking the latest students' attendance registers. The school admission numbers of students were entered into an Excel spreadsheet and categorised by years of education. The same was done to the names of teachers in each school. From each Excel spreadsheet, admission numbers were picked using Excel's RANDBETWEEN function to satisfy the stratification in Table 4.1. The study population revealed that the population of teachers in all six schools averaged at 5.5% of the population of students as shown in Table 4.7. Therefore, of the sample size derived from the student population, 5.5% was reserved for teachers.

Table 4.7: Proportion of number of teachers to student population in NEPAD e-Schools

School	No. Of Female Teachers	No. Of Male Teachers	Total	No of Students	Teachers as % of Students
Chevakali High School	21	38	59	1098	5.3
Isiolo Girls Secondary School	8	15	23	430	5.3
Maranda High School	10	48	58	1262	4.6
Menangai High School	31	24	55	689	7.9
Mumbi Girls Secondary School	17	11	28	582	4.8
Wajir Girls High School	6	21	27	507	5.3
Average					5.5

With the exact respondents in the sample agreed on, the ICT champions were given questionnaires to distribute to the persons identified in the sample. The instruction was for the completed questionnaires to be submitted to the ICT champion; the research assistant was to collect them after one week. The research assistants made second or third visits to the schools to collect the completed questionnaires. Collection was efficient with the exception of Wajir Girls High School, where form four students refused to return their completed questionnaires. With the end of the exams, the students returned to their rural homes and could not be reached. Their questionnaires were never returned.

4.7.3 Challenges encountered during the administration of research instruments

Designing data collection normally takes into consideration cost, data quality, duration and manageability. Some of these aspects could not be clearly revealed through the pilot study. For example, managing appointments with the principals of schools proved to be challenging. The principals were focusing their attention on national examinations at the time. While it was anticipated that with the examinations in progress, the principals would be easily accessible in school, getting them to settle down for interviews was difficult because their attention was often distracted. In some cases, the interview had to be discontinued for an hour or two to allow the principal to attend to emerging issues.

Travel posed another constraint. All the schools except Menengai High School were in remote locations. These locations are far from major towns and tarmac roads. The journey to Wajir Girls High School, for example, was quite challenging. There was a stretch of 320 km of partly all weather road, and partly vague paths made by vehicles on sand. The terrain was rugged, and even the four wheel car that was hired for the purpose got stuck on some sections of the road.

In some schools, receiving completed questionnaires was not easy. The teachers postponed the collection dates, citing their commitments to the preparation of practical examinations, assisting students' preparations for examinations, and marking continuous assessments. A similar situation was encountered with the students. Some students appeared to have answered questions without giving the questions enough thought.

4.8 Data analysis

Data analysis was performed continuously while data was being collected. Any time data collection instruments were returned to Nairobi (control centre), the data analyst subjected them to the analysis process which included data cleaning, data coding and data entry.

4.8.1 Data cleaning

Before data could be entered into statistical software for analysis, necessary steps were taken to detect and remove all errors that could be identified manually. The process of improving data quality at the end of collection is called data cleaning (Han & Kamber, 2007). Data cleaning is one of the most tedious processes in preparation for data analysis. While there are some tools, like data scrubbing software, available for detecting errors in data, most of the detection still relies on knowledge of the data (metadata) and experience with data analysis (Olson, 2003). One of the tasks involved in data cleaning included identifying and correcting inappropriate responses in the open-ended questions in the questionnaire. For example, in the questionnaire for the current study, if a student in Isiolo Girls High School entered their gender as 'male', this would certainly be wrong and need to be corrected.

A sample of completed questionnaires was picked from a set of each school. They were perused for inconsistencies in responses and no responses. The questionnaires that tended to have a high lack of responses had their serial numbers recorded for follow up at later stages in data analysis. Similarly, questionnaires with vague responses to the open-ended questions were identified and marked for exclusion at the stage of coding those responses.

4.8.2 Data coding

An effective way of analyzing a large amount of survey data is to ensure that as much data as possible is coded. Coding was effected in two stages: at the design stage of the questionnaire in the case of quantitative data or data which may be transformed into quantitative responses, and at the stage of data cleaning. Pre-coding was used to help reduce the cost of analysing data (Sapsford & Jupp, 2006). The questionnaire used in this study was pre-coded and its coding was improved during the pilot phase of the project. The open-ended questions were categorised through listing and coded before data was entered into the statistical software.

4.8.3 Data entry

With data cleaning, editing and coding completed, a code book was prepared using the Statistical Package for Social Sciences (SPSS), version 11.5. SPSS was chosen to analyze data because of its robustness in descriptive statistics, parametric statistics, and factor analysis. Very few statistical packages have such wide capabilities. Secondly, the software is available in student versions which are cheap to maintain. Lastly, the researcher has experience with the software and could therefore easily perform data mining using SPSS.

A data analyst was, however, contracted to undertake the initial data coding of open-ended questions before the researcher verified the coding. Since the code book was large (i.e. had many variables), the data analyst was contracted to prepare the code book. The number of completed questionnaires was also large. The actual data entry was divided among three data entry clerks working under the data analyst. Data entry was conducted in the second week of January 2011. The data was then analysed with the aim of accepting or rejecting the seven hypotheses of the study clustered under the five objectives as discussed in 4.8 below.

4.9 Hypotheses testing

This study was designed to evaluate the success of the pilot phase of the NEPAD e-School project using both qualitative and quantitative data. Quantitative data was collected for each dimension of the e-School. This therefore made it possible to test hypotheses that had been advanced for each objective of the study.

4.9.1 Objective 1: Installed ICT infrastructure for enhancing teaching and learning

This objective broadly assessed the installed infrastructure, its quality, accessibility and suitability for integration into blended learning. The objective was answered by first conducting an observation of the installed infrastructure and then testing the following three hypotheses:

Hypothesis 1: The quality of the installed e-School infrastructure (the IS) determines the level of success of the e-School initiative.

The contribution to success of the e-School initiative based on the quality of the installed e-School infrastructure was evaluated through the independent variable $V_{1,}$ the *e-School infrastructure quality*.

4.9.1.1 V_1 - E-School infrastructure quality

In order to evaluate the e-School infrastructure quality, the questionnaire solicited respondents' perceptions of the quality of the specific components of the e-School system and their suitability for the e-School. The question items covered convenience of access and the reliability of the system. The question items were rated on a four level Likert scale, with 1 representing 'strongly disagree', and 4 representing 'strongly agree'. The respondents were also presented with four open-ended questions to enable them to express their opinions on the quality of the system. Examples of open-ended questions are: "What aspect of the e-School infrastructure would you suggest should be urgently improved?" and "What action would improve the aspect of the system you have described above?" The inclusion of open-ended questions was intended to facilitate exploration (Jackson & Trochim, 2002) on the dimension of e-School quality and therefore supplement the close-ended questions. The number of open-ended question items was limited to reduce non response and non specific responses (Schwarz & Oyserman, 2001).

Hypothesis 2: The quality of information content and communication contributes to the level of success of the e-School initiative.

The contribution to the success of the e-School initiative based on the quality of information content and communication was assessed through the evaluation of V_2, *e-School content and communication quality*.

4.9.1.2 V_2 – e-School information content and communication quality

The e-School system should deliver to the learner content that is relevant to the curriculum. Part of this content is developed by teachers collaborating through the e-School system. This is a new initiative taking departure from traditional publishing which is known to undergo a thorough peer review process. The content generated by the collaborating teachers is therefore subject to evaluation by the users. The learners are also required to develop a culture of collaboration and therefore teamwork. This is achieved through communication with peers in other e-Schools through e-mail. This independent variable therefore reveals the adequacy of the content and efficiency of communication to support the stated goal.

In evaluating information content and communication quality, the questionnaire presented questions relating to the efficiency of accessing information content, relevance of the content to the curriculum, format quality of the content, reliability of information exchange with peers in other e-Schools, and availability of local content developed by collaborating teachers within the e-School's WAN.

Hypothesis 3: High service quality offered by the technical personnel contributes to the success of the e-School system.

The third hypothesis facilitates the assessment of the contribution of the service quality offered by technical personnel to the success of the e-School system. This was achieved through the evaluation of V_3, *e-School service quality*.

4.9.1.3 V_3 - e-School service quality of technical staff

As stated earlier, the e-School system requires maintenance and its users need user support. User support becomes vital when a session is interrupted either by system instability, or when a user sends an inappropriate command that generates an error. Users of the system are at various levels of computer proficiency and self-efficacy. Some students may not have completed the training sessions and would therefore lack the competence required to navigate their way through the e-School system. In evaluating the service quality, respondents were first asked to state the expected service level they desired, the perceived service level offered by the technical personnel, and lastly to estimate the gap between the expected service level and the perceived service level. The questionnaire presented measurement items for this dimension in three parts: one for expected service level, two for the perceived service level, and three for the service gap (Pitt et al., 1995). An example of a statement under perceived service level is: "When information system personnel promised to fix a problem by a certain time they did so." A corresponding item under expected service quality level is: "When these information system personnel promise to fix a problem by a certain time they will do so." The distinction between the two statements is in the tense - one is past while the other is future. An elaborate instruction was given to the respondents at the opening of the section to guide them in identifying the appropriate response.

4.9.2 Objective 2: Effectiveness of the training of teachers and learners

The goal of this objective was to bring out the methods of training that learners and teachers were exposed to and the impact that training had on their ability to productively put into use the e-School system. This goal was achieved by testing the hypothesis below:

Hypothesis 4: Effective training methods and approaches contribute to the success of e-School system.

Hypothesis 4 was tested through the evaluation of the independent variable V_4, *e-School training effectiveness*.

4.9.2.1 V_4 – e-School training effectiveness

The training provided to users of the e-School system has a dual objective depending on the beneficiary. Teachers in e-Schools are generally trained to make them ICT proficient and to enable them to change their pedagogies and adapt those appropriate to the integration of ICT in teaching and learning. Training of learners, however, is restricted to the first objective, i.e. making the learners ICT proficient. In evaluating this variable, the respondents were asked to indicate whether they were exposed to a variety of training methods. The respondents were required to select from a variety of optional training methods. The respondents were also asked about how they were trained/ training approaches. They were expected to select between the lecture-based approach and behaviour modeling approach. The respondents were finally asked to evaluate the training method and approach according to the extent to which their anxiety with respect to ICT use was reduced (Compeau & Huggins, 1995) and the extent to which their computer self-efficacy was increased (Chou, 2001), and their perception of the effectiveness of the training in enabling them to use the e-School system productively.

4.9.3 Objective 3: E-School Use

The third objective was to establish the extent to which the e-School system was being used to enhance teaching and learning. Both learners and teachers must engage in the use of the e-School system in order to facilitate the achievement of the system's goal. Not all uses are productive. Only those uses which are aligned to curriculum objectives are of importance in this assessment. To evaluate the e-School use, the fifth hypothesis below was tested:

Hypothesis 5: High and exploitative use of the e-School system contributes towards the success of the e-School system.

Hypothesis 5 was tested through the evaluation of independent variable V_5, *e-School use*.

4.9.3.1 V_5 – e-School use

The evaluation of this variable was two-pronged. On the one hand, the extent of use was evaluated, which is a measure of how much the system is in use with respect to both frequency and variety. Frequency measures how often a teacher or learner uses the system. Variety establishes the different purposes for which the learners or the teachers use the system. For example, with respect to a learner, the system could be used to communicate with peers in other e-Schools on academic issues and also identify additional relevant materials from other databases. The former purpose encourages teamwork, while the latter enhances self directed learning which inculcates lifelong learning. The other aspect of measuring use is exploitative, or the depth of use of the e-School system. Depth of use facilitates the generation of new knowledge or innovation. Innovative use of the e-School system is vital, particularly because the NEPAD e-School has not been in existence for long. Not enough experiments have been done with the e-School system to corroborate its theoretical benefits. Innovation enables the discovery of better ways of using a system to obtain optimal benefits. In evaluating this independent variable, respondents were asked to evaluate the ease of use of the e-School, frequency of use by both teachers and learners, purpose of use, enjoyment of use, mode of use, and complaints about settings circumventing use.

4.9.4 Objective 4: E-School user (learner and teacher) satisfaction

The fourth objective of the study was to determine the extent to which e-School users (students and teachers) believed the e-Schools prepared students to function in the global economy. This is an evaluation of user satisfaction which is achieved by testing the sixth hypothesis below:

Hypothesis 6: High level of satisfaction of teachers and students with an e-School system (all aspects including infrastructure quality, information content and communication quality, service quality, use, and training effectiveness) contributes to the success of the e-School system.

In order to evaluate the contribution of user satisfaction to the success of the e-School, an evaluation of the independent variable V_6, *e-School user (learner and teacher) satisfaction,* was performed.

4.9.4.1 V_6 – e-School user (learner and teacher) satisfaction

Users of the e-School system develop an evaluative opinion of the system because they interact with the various dimensions of the system. This evaluation encompasses the entire system, ranging from infrastructure to information content and communication, training effectiveness, service by technical personnel and system use. The respondents were asked to express their relative level of satisfaction with the e-School system with respect to the sufficiency of content, efficiency of locating content, access to more content, communication efficiency, and availability of relevant health information.

4.9.5 Objective 5: E-School net benefits

The fifth objective was to establish the extent to which the e-School improves the efficiency of school management, the processes of teaching and learning, and the quality of graduating students. This is summarized as e-School benefits, which were established by testing hypothesis number seven below:

Hypothesis 7: Net benefits of the e-School contribute to the success of the e-School system.

In order to test whether the net benefits of an e-School contribute to the success of the e-School system, the study evaluated V_7, *e-School net benefits*.

4.9.5.1 V_7 - e-School net benefits

An e-School accrues net benefits if its objectives are attainable. For example, one of the main objectives of an e-School is to improve the quality of graduating students. This would be evident in the extent to which students are prepared to fit in modern work life. Modern work life is intensive in computer use and therefore students should be able to acquire computer skills, develop teamwork skills through collaboration, and develop lifelong learning skills. Developing lifelong learning requires learners to engage in self directed learning, which is achieved by acquiring learning materials independently. These benefits were evaluated by asking e-School users to rate their perception of the extent to which the objectives of the e-School system were being achieved. Some of the related questions were stakeholders' preferences for the e-Schools, contribution of the e-School to the efficient use of resources, level of enjoyment when learning using the e-School system, contribution to independence in learning, and contribution to teamwork skills.

4.10 Summary

The road map for data collection was laid out in this chapter, beginning with an explanation of the concepts of research, research design and tools for data collection. A detailed description of expectations and how the design was actually made and implemented was provided. In particular, the design process of the observation schedule, interview schedule and questionnaire, and how these instruments were implemented, was described in detail. This was followed by a discussion of the treatment of data. The chapter explained how analyses of data (to reject or accept the seven hypotheses of the study) were clustered under the study's five objectives to facilitate the testing of the seven postulated hypotheses.

The next chapter describes the process of data analysis and presents the findings of the study.

CHAPTER FIVE

DATA PRESENTATION AND ANALYSIS

5.1 Introduction

The purpose of this study was to evaluate the success of NEPAD's pilot e-Schools in Kenya using a re-specified version of DeLone and McLean's (2003) IS Success Model, i.e. the E-School Success Model. The study targeted the six schools NEPAD's e-Africa Commission had selected for the pilot in the country, i.e.: Chevakali High School in Western Province, Maranda High School in Nyanza Province, Menengai Mixed Secondary School in the Rift Valley Province, Isiolo Girls Secondary School in the eastern region, Mumbi Girls Secondary School in Central Province, and Wajir Girls Secondary School in the north eastern region. The six e-schools and their students and teachers constituted the study's population. The chapter describes how the data collection instruments were treated upon being returned from the field and the procedure that was followed in preparing the data for analysis. Analysed quantitative data is then presented with frequency runs and cross-tabulation, while qualitative data is presented as information in descriptive form.

Data analysis is divided into three parts. The first part of data analysis ascertained the reliability and validity of the questionnaire. Reliability falls into three categories, namely stability, equivalence and internal consistency (Martella, Nelson & Marchand-Martella, 1999). The first two require the administration of a research instrument more than once. This study opted to validate the research instrument using internal consistency. Internal consistency refers to the tendency of different items to evoke the same response from any given respondent on a single administration of the measurement device (Martella, Nelson & Marchand-Martella, 1999:68). (Reliability is the consistency of results over time. The common measure of reliability using internal consistency is Cronbach's coefficient alpha (1951). According to Nunnally and Beirnstein (1994), an instrument is considered consistent if Cronbach's alpha is 0.70 and above. This study used Cronbach's alpha to assess the internal consistency of the questionnaire.

The second stage of the analysis involved exploratory and confirmatory factor analyses to test the validity of the questionnaire as a multi-dimensional measure of the conceptualized E-School Success Model. These analyses sought to determine the construct validity of the question items in each of the seven dimensions of the E-School Success Model and also to estimate the consistency of the measurement items in two data sets. Ascertaining construct validity and measurement consistency is taken as confirmation that groups of measurement items measure the attributes of the target dimension and therefore validate the E-School Success Model.

There are two types of validity: internal and external validity. Internal validity is the confidence that there is a functional relationship between the independent and dependent variable (Martella, Nelson & Marchand-Martella, 1999:38). In assessing internal validity, attention is drawn to construct validity. A measure has construct validity if the set of items constituting the measure faithfully represents the set of aspects of the theoretical construct measured, and does not contain items which represent aspects that are not included in the theoretical construct (Forza, 2002). Construct validity is further divided into convergent validity and discriminant validity. These validities were assessed using factor analysis and the correlation coefficient between the items and the constructs.

The third stage of the analysis involved data mining to ascertain the extent to which the NEPAD e-School was succeeding. Measurement of success was achieved using a Likert scale of one to four, and the success indicator was how close the respondents' perceptions were to agreeing with the statements that were posed. The mean ordinate value was used to assess the level of success of each dimension by determining the level of significance of the variances in measurement value from mean ordinate value.

5.2 Validation of the survey questionnaire

SPSS was used to perform instrument validation. Two components of validation were implemented, namely reliability and validity tests.

5.2.1 Reliability of the instruments

To increase the reliability of the study, the instruments of the study were tested for data stability, internal consistency, and validity in general.

5.2.1.1 Stability of the results

Reliability was conducted in two stages. In the first stage, the data was split into two using the random procedure of SPSS. Reliability assessment was done on each data set to facilitate the comparison of corresponding alpha values and thus verify the stability of the results. Table 5.1 shows exploratory alpha in the middle column and confirmatory alpha in the right column. The differences between exploratory alpha and confirmatory alpha were very small, confirming that the results were stable.

Table 5.1: Test and confirmatory alpha

Dimension	Exploratory Alpha	Confirmatory Alpha
Infrastructure Quality	0.6592	0.704
Information Content and Communication Quality	0.7448	0.7416
Service Quality	0.7182	0.754
Training Effectiveness	0.3962	0.4818
Extent and Exploitative Use	0.7893	0.7766
User Satisfaction	0.916	0.9071
Net Benefits	0.8519	0.822

A scatter plot of the alpha of the two sets of data shows a very close relationship and confirms the stability of the data (see Figure 5.1).

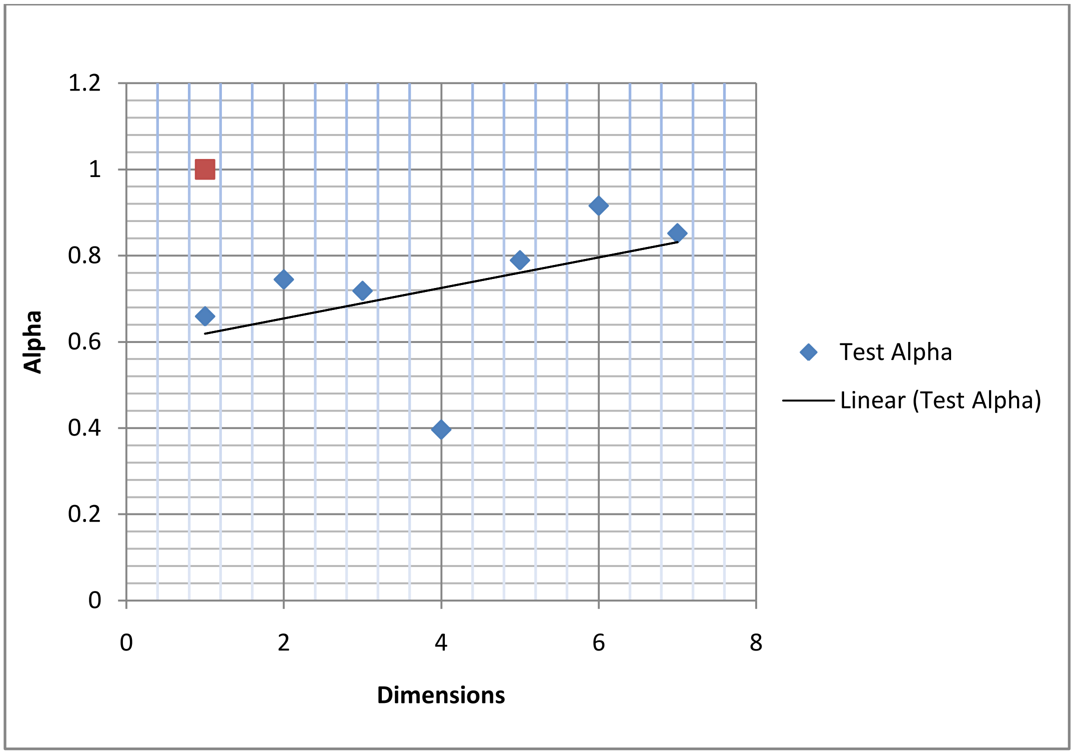

Figure 5.1: Scatter Plots of Test and Confirmatory Alpha

5.2.1.2 Internal consistency

In the second stage, the complete data was used to determine internal consistency using item total correlation coefficients. Internal consistency is high if the correlation coefficients' alpha values are at least 0.7 or better. Table 5.2 shows Cronbach's alpha values for the item total correlation coefficients. All the seven dimensions had a high loading factor above 0.7 except the training effectiveness dimension whose Cronbach alpha value was below 0.7. The value of 0.4419 with respect to training effectiveness is, however, acceptable. Training effectiveness is a newly conceptualized dimension in the E-School Success Model. The Cronbach alpha value is acceptable if it is above 0.4, the minimum value allowed for an exploratory instrument (Vandapalli & Mone, 2000). Thus all the Cronbach alpha values fall within the range of information systems' studies.

Table 5.2: Cronbach's alpha of item total correlation coefficients

Dimension	**Cronbach Alpha**
Infrastructure Quality	0.6852
Information Content and Communication Quality	0.7422
Service Quality	0.7368
Training Effectiveness	0.4419
Extent and Exploitative Use	0.7829
User Satisfaction	0.9129
Net Benefits	0.8377

5.2.2 Validity

Factor analysis was performed using principal component analysis (PCA) to determine the number of factors that can be extracted and fit the model. During conceptualization, it was theorized that the E-School Success Model has seven dimensions. A scree test was plotted (see Figure 5.2), and in the diagram, the elbow of the scree plot is exactly midway between 5 and 9 factors. The scree plot therefore confirms that the E-School Success Model has seven dimensions.

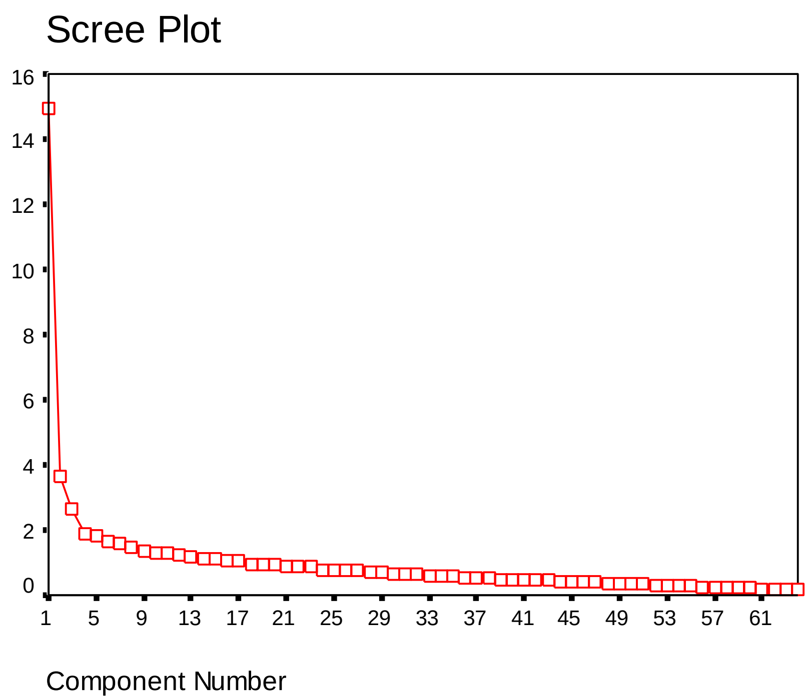

Figure 5.2: Scree plot of possible factors

A factor extraction table was drawn to identify the measurement items which load to specific factors (dimensions). These clusters are shown in Table 5.4. The measurement items were grouped according to the factors to which they load with the highest correlation coefficients. Other possible factors to which very few measurement items loaded (one to three) or for which the item loading was low (below 0.1) were screened. Subsequently, seven factors were identified. By cross referencing the conceptualized dimensions and the corresponding measurements, the factors extracted correspond to the dimensions in Table 5.3.

Table 5.4: Measurement items and their factor loading

Item	Components/Dimensions						
	1	2	3	4	5	6	7
E-school software is user friendly	0.599						
E-school smart boards project clearly	0.598						
E-school computer keyboards and screens are well designed for my	0.575						
The speed of e- school computer hardware is good	0.567						
E-school printers are easy to use	0.562						
The e-school system has a reliable power back up	0.544						
The e-school's Windows Operating System makes it easy for me to navigate the e-school's services	0.524						
The buildings that house e-school equipment are suitable for computer laboratories	0.500						
It has been possible for me to get materials from other e-schools on time		0.750					
I have established friends through networks that link my school to other e-schools		0.714					
Exchange of ideas with peers via e-mail has been efficient		0.683					
Some teachers in my school participate in developing content which is posted onto the e-school system and shared with other e-schools		0.646					
The format quality of content in the e-school system has encouraged me to use the system		0.618					
It is efficient - getting complete reading materials through the e-school system		0.605					
The content retrieved from the e-school system is specific and relevant to the curriculum		0.307					
The technical personnel are pleasant to work with			0.708				
IS technical staff gave users personal attention			0.647				
I would rate the quality of the service provided by IS technical staff as adequate			0.645				
IS technical staff are knowledgeable			0.572				
When IS technical staff promised to fix a problem by a certain time, they did so			0.562				
The e-school system is always kept in good working order			0.503				
IS technical staff should be knowledgeable			0.539				
IS technical staff should give users personal attention			0.533				

If IS technical staff promise to fix a problem by a certain time, they should do so			0.409				
Training on using the e-school gave me hands-on experience in the use of the computer system				0.744			
Training on using the e-school encouraged me to use the e-school system				0.712			
The training approach used was largely demonstrative				0.601			
Trainers used different training methods				0.475			
The training approach used was largely lecture-based				0.105			
I need additional training on using the e-school				0.235			
I use the e-school system to get additional material specific to the curriculum					0.729		
My teacher gives me additional exercises through the e-school system					0.690		
I use the content of the e-school system for independent learning					0.673		
I use the e-school system to get lessons from other e-schools					0.670		
I use the e-school system to collaborate with peers in other e-schools					0.666		
I enjoy using the e-school system for learning purposes					0.647		
Students and teachers frequently use the e-school system					0.635		
Teachers incorporate the use of the e-school system in classroom teaching					0.500		
The e-school system is easy to use					0.495		
Some rules imposed by the school prevent the exploitative use of the e-school system					0.007		
At times I access content which is not relevant to the curriculum from the e-school system					0.376		
The e-school system enables me to learn the content I need						0.778	
The e-school system provides sufficient content						0.734	
The e-school system provides personalized learning support						0.734	
As a whole, the e-school system is a success						0.733	
The e-school system enables me to control my learning progress						0.727	
As a whole, I am satisfied with the e-school system						0.724	

The e-school system makes it easy for me to find the content I need						0.720	
The e-school system provides content that exactly fits my needs						0.715	
The e-learning system makes it easy for me to share what I learn with the learning community						0.713	
The e-school system makes it easy for me to discuss questions with my teachers/ peers						0.703	
As a whole, the e-school system's health component is informative						0.647	
The e-school system is user-friendly						0.610	
The e-school system is easy to use						0.591	
As a whole, my use of the e-school system is voluntary						0.440	
My understanding of a lesson normally improves when I review the topic from e-school content							0.768
My ability to work in a team has improved since I started using the e-school communication system							0.743
Infrastructure/ resources in e-schools help students perform better							0.734
Teaching and learning in e-schools is more enjoyable							0.726
Installation of e-schools facilitates the efficient use of resources							0.700
The e-school system encouraged me to learn independently							0.669
The e-school system facilitates collaboration between teachers and students in different schools							0.617
Users of e-schools are willing to offer recommendations that could lead to possible improvements							0.586
My parents prefer the e-school over non e-schools							0.420

Table 5.3: Extracted factors and corresponding dimensions

Factor	Dimension
1	Infrastructure quality
2	Content and communication quality
3	Service quality
4	Training effectiveness
5	Use
6	User (students and teachers) satisfaction
7	Net-benefits

5.3 Response characteristics

In its design, the study was made respondent friendly by making the instruments short but exhaustive, and using simple language to accommodate the understanding of both students and teachers. This was necessary to avoid a poor response rate which often results in inaccurate results (Holbrook, Krosnick, & Pfent, 2007). The next sub-sections discuss the response rate, distribution of respondents by gender, and distribution of respondents by level of education and designation as teacher or student**.**

5.3.1 Response rate

A response rate is a comparison between the number of returned and completed questionnaires and the sample size (which should match the number of distributed questionnaires). A total of 1,508 questionnaires were distributed to teachers and students in the six schools. After a dedicated follow up by ICT champions, a total of 776 completed questionnaires were returned (a response rate of 51.4%). Table 5.5 shows the response rate of each school.

Table 5.5: Response rate by school

Schools		Sample	Respondents	Percentage response
	Chavakali Boys High School	332	127	38.3
	Isiolo Girls High School	129	126	97.7
	Maranda High School	392	115	29.3
	Menengai Secondary School	317	135	42.6
	Mumbi Girls	184	150	81.5
	Wajir Girls	154	123	79.9
	Total	1508	776	51.5

The respondents were categorized by their gender and designation as teacher or student. Overall, there were more female respondents (56%) than male respondents (44%). This is partly because of the six schools, three were girls-only schools (Isiolo Girls High School, Mumbi Girls High School and Wajir Girls High School) and one school, Menengai Secondary School, was co-educational.

5.3.2 Students' response rate by gender

The students' response rate by gender is presented in Table 5.6. The response rate among female students was much higher than male students. The difference in response propensity between the genders is 42.86%. Within this study, female students also agreed more that ICT makes learning more interesting.

Table 5.6: Gender distribution of the student respondents

		Response Frequency	Sample size	Valid Percent
Valid	Female	417	533	78.2
	Male	313	885	35.4
Total		730	1418	

The response rate amongst students was not symmetrical across the six schools. Some schools were very cooperative and yielded a commendably high response rate while others recorded dismally low response rates. The cooperation was generally higher in girls' schools.

5.3.3 Distribution of student respondents by class

Within the schools, there was no fixed pattern for the response rate by class level (form I, II, III and IV). The response rate by students' class level is shown in Table 5.7.

Table 5.7: Distribution of student respondents by class

	Response Frequency	Sample size	Response rate
Form 1	168	436	38.5
Form 2	264	392	67.4
Form 3	203	361	56.2
Form 4	95	319	29.8
	730	1508	

This data shows that the lowest rate of response was attributable to form fours (29.6%) and the highest cooperation stemmed from form two students (67.5%). The low response rate among form four students was attributed to the pressure of time imposed by national examinations which were being taken at the time of data collection. For form four students in particular, these examinations are extremely important as it is the entry qualification to university education. As has been reported, form fours in Wajir Girls High School failed to return their completed questionnaires.

5.3.4 Distribution of teacher respondents by school

Of the 90 teachers who were sampled, 41 returned their completed questionnaires (a response rate of 46.7%). The distribution of the response rate of teachers by school did not follow any known pattern. However, it was lower than the response rate achieved among students. There did not appear to be any relationship between students' response rate and teacher's response rate in a school.

Table 5.8: Distribution of teacher respondents by school

School	Response frequency	Sample size	Response rate
Chevakali Boys High School	12	18	66.7
Isiolo Girls High School	4	10	40.0
Maranda High School	9	21	42.9
Menengai Secondary School	7	17	41.2
Mumbi Girls	5	13	38.5
Wajir Girls	4	11	45.5
Total	**41**		

5.4 Analysis of the success of the e-School's dimensions

The objective of the study, the evaluation of NEPAD's e-School success, was to be achieved by a step by step evaluation of the success of each dimension. This section therefore analyses the data collected with respect to each of the seven e-School dimensions, namely infrastructure quality, content and communication quality, service quality, training effectiveness, use, user (student and teacher) satisfaction, and the net benefits.

5.4.1 Installed ICT infrastructure for enhancing teaching and learning

Installed infrastructure ranged from the buildings that functioned as computer laboratories to the quality of the hardware and software of the computers. Generally, respondents agreed or highly agreed that the quality of installed infrastructure was good. For example, 87.2% of the students and 77.5% of the teachers agreed or highly agreed that the computer laboratories were suitable (Table 5.9 and Table 5.10). The aspect of the e-School eliciting the lowest level of agreement from the two groups was the quality of the power back-up system. Only a slight majority of students (52.5%) and a sizeable proportion of teachers (40%) agreed or highly agreed with the notion that the e-School system had reliable power back-up. This low level of agreement is attributable to the lack of generators to run the system in the computer laboratories whenever there was a power interruption.

Table 5.9: Students' level of agreement with the quality of infrastructure

Attribute of Installed Infrastructure	Strongly disagree	Disagree	Agree	Strongly agree	Total	% Agree
The buildings that house e-School equipment are suitable for computer laboratories	46	44	225	389	704	87.2
E-School computer hardware is good	99	171	270	177	717	62.3
E-School smart boards project clearly	42	96	283	287	708	80.5
E-School software is user friendly	48	90	275	287	700	80.3
The e-School's windows operating system makes it easy for one to navigate the system	63	120	301	223	707	74.1
E-School system has reliable power back up	166	172	215	159	712	52.5
E-School computer keyboard and screens are suitable for my use	63	71	239	340	713	81.2
E-School printers are easy to use	157	121	233	204	715	61.1

Table 5.10: Teachers' level of agreement with the quality of infrastructure

Attribute of Installed Infrastructure	Strongly disagree	Disagree	Agree	Strongly agree	Total	% Agree
The buildings that house e-School equipment are suitable for computer laboratories	4	5	17	14	40	77.5
E-School computer hardware is good	4	12	19	5	40	60.0
E-School smart boards project clearly	2	6	17	12	37	78.4
E-School software is user friendly	3	9	16	11	39	69.2
The e-School's windows operating system makes it easy for one to navigate the system	1	4	27	8	40	87.5
E-School system has reliable power back up	12	12	10	6	40	40.0
E-School computer keyboard and screens are suitable for my use	1	4	24	11	40	87.5
E-School printers are easy to use	4	13	17	6	40	57.5

On average, as depicted in Table 5.11, the responses to each aspect of infrastructure quality was higher than 2.0, the mid-point of the Likert scale which also corresponds with the highest ordinate point for disagreement with evaluative statements. This confirms that the majority of the respondents were agreeing with the evaluating question items that the quality of infrastructure was good. The highest mean was 3.3 (quality of buildings) and the lowest mean, 2.5 (reliability of the power back-up system).

Table 5.11: Mean perceptions of the quality of installed infrastructure

Attribute of Installed Infrastructure	No.	Mean
The buildings that house e-School equipment are suitable for computer laboratories	744	3.3
E-School computer hardware is good	757	2.7
E-School smart boards project clearly	745	3.1
E-School software is user friendly	739	3.1
The e-School's windows operating system makes it easy for one to navigate the system	747	3.0
E-School system has reliable power back up	752	2.5
E-School computer keyboard and screens are suitable for my use	753	3.2
E-School printers are easy to use	753	2.7

All the eight means were statistically different from the expected mean at a 99% level of confidence, except the mean response on reliable power back up whose chi-square value was 10.713, degree of freedom (df), 3, and significance, 0.013. The chi-square value of 10.713 is relatively low, and with the level of significance higher than the set test value of 0.01, this aspect of infrastructure does not meet the expectations of students and teachers.

Respondents made suggestions on aspects of the infrastructure that should be considered for improvement. They also suggested the improvements they would like to see implemented. A sizeable proportion (27.4%) identified internet connectivity as an aspect that needs improvement. This was followed by the size of computer laboratories (18.4%) and the number of computers (18.0%). Computer hardware speed was also identified for improvement by 16.6% of the respondents. Other infrastructure aspects that were mentioned included printers, networks and air conditioning. The explanations offered for the aspects identified were very specific. Some 32% of the respondents felt that the number of computers was not adequate, 11.7% felt that teachers should provide more information, while only 4.7% felt that computer systems were always available for their use.

Overall, however, over half of the respondents (56.4%) were satisfied with the quality of the infrastructure at the time of writing. This perception was analyzed at individual school level and revealed that the number of those happy with the infrastructure quality was higher than those who were not happy in four schools. The overall mean was, however, statistically significant with a chi square value of 75.538 and p value of 0.000. The responses are shown in Tables 5.12 and 5.13.

Table 5.12: Satisfaction with the quality of infrastructure by school

School	Yes	No	Total	% satisfied
Chavakali Boys High School	72	53	125	57.6
Isiolo Girls High School	81	23	104	77.9
Maranda High School	37	70	107	34.6
Menengai Secondary School	47	70	117	40.2
Mumbi Girls	77	69	146	52.7
Wajir Girls	83	22	105	79.0
Total	397	307	704	56.4

Yes = Satisfied; No = Not satisfied

Table 5.13: Chi-square test statistics for satisfaction with the quality of infrastructure

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	75.538(a)	5	.000
Likelihood Ratio	78.734	5	.000
Linear-by-Linear Association	.528	1	.467
N of Valid Cases	704		

0 cells (.0%) have expected count less than 5. The minimum expected count is 45.35.

From observation, the installed infrastructure varied from one school to the next. The access roads to some schools were graded tarmac roads while others were all weather roads (see Figure 5.3 taken from Wajir Girls High School). The roads were, however, adequate for the transportation of fragile equipment.

Figure 5.3: Access road to Wajir Girls High School

All six of the e-Schools had at least one computer laboratory for students and their teachers to access ICT for teaching and learning. The computer laboratories were installed with computers of varied numbers (see Table 5.14), data switches or hot spots, LCD projectors, televisions, and smart screens. The networking approach was different in the different schools. Wajir Girls High School and Menengai High School had wireless networks while the other schools used cabled ethernet.

Table 5.14: Number of computer laboratories and computers in each school

Schools	Laboratories	Computers
Chevakali Boys High School	04	75
Isiolo Girls High School	01	20
Maranda High School	01	40
Menengai Secondary School	02	22
Mumbi Girls	01	20
Wajir Girls	01	22
Total	10	199

The treatment and arrangement of computers within the laboratories was also different. In Wajir High School and Menengai High School, the computers were properly housed in a protective casing (see Figure 5.4 taken from Menengai High School). In Chevakali High School, the computers were installed on benches that lined the wall, leaving the central space in the room for class-style seating.

In Mumbi Girls, the computer laboratory was specifically built with concrete benches for computers (see Figure 5.5).

Figure 5.4: Computer laboratory in Menengai High School

Figure 5.5: Computer laboratory in Mumbi Girls High School

Each e-School's LAN was connected to a Very Small Aperture Terminal (VSAT) for a satellite link to facilitate internet connection. An example of a VSAT mounted to a wall of a computer laboratory in Isiolo Girls High School is shown in Figure 5.6.

Figure 5.6: VSAT at Isiolo Girls High School

5.4.2 Information content and communication quality

Teachers and students were presented with questions evaluating the efficiency with which they could obtain reading materials, relevance of the content to the curriculum, efficiency with which they could exchange ideas with peers in other e-Schools, format quality of content, availability of materials from other e-Schools, participation of teachers in developing content, and the establishment of friends through an e-School network. The responses could be divided into two categories, i.e. those relating to content within the LAN and those relating to communication outside the school. The majority of the students (68.4%) expressed satisfaction with the content quality. On the other hand, communication effectiveness and quality were rated poorly with only 44.2% of students claiming that the quality of communication was good. The most poorly rated aspect of communication was the ability to network with peers from other e-Schools. Only 35.5% of the students claimed that they had established friends through connections between their schools and other e-Schools. Table 5.15 provides data on students' perceptions of content and communication quality.

Table 5.15: Students' perceptions of e-School content and communication quality

Aspects of Content and Communication	Strongly disagree	Disagree	Agree	Strongly agree	Total	% Agree
It is efficient getting complete reading materials through the e-School system	109	162	242	197	710	61.8
The content retrieved from the e-School system is specific and relevant to the curriculum	71	125	313	195	704	72.2
Exchange of ideas with peers through e-mail has been efficient	259	125	156	174	714	46.2
The format quality of content in the e-School system has encouraged me to use the system	94	108	283	220	705	71.3
It has been possible to get materials from other e-Schools on time	251	179	168	108	706	39.1
Some teachers in my school participate in developing some content which is posted to the e-School system and shared with other e-Schools	194	121	183	210	708	55.5
I have established friends through interconnection between my school and other e-Schools	324	130	125	128	707	35.8

The opinions of teachers correlated well with those of students. A majority of the teachers (69.2%) agreed that the quality of content of the e-Schools was good. A slightly smaller number (48.1%) felt that the quality of communication was good. However, the responses of teachers on the ability to network with peers in other e-Schools were drastically different from those of students, with 56.4% of the teachers claiming to have formed networks compared to 35.8% of the students. Table 5.16 shows teachers perceptions of e-School content and communication quality.

Table 5.16: Teachers' perceptions of e-School content and communication quality

Aspects of Content and Communication	Strongly disagree	Disagree	Agree	Strongly agree	Total	% Agree
It is efficient getting complete reading materials through the e-School system	4	9	19	7	39	66.7
The content retrieved from the e-School system is specific and relevant to the curriculum	2	7	23	7	39	76.9
Exchange of ideas with peers through e-mail has been efficient	7	16	9	7	39	41.0
The format quality of content in the e-School system has encouraged me to use the system	7	7	24	1	39	64.1
It has been possible to get materials from other e-Schools on time	10	12	11	6	39	43.6
Some teachers in my school participate in developing some content which is posted to the e-School system and shared with other e-Schools	10	9	10	10	39	51.3
I have established friends through interconnection between my school and other e-Schools	5	12	14	8	39	56.4

The average perceptions of the study population based on the Likert scale are shown in Table 5.17. All the average perceptions are above the mid-point ordinate value of 2.0, the highest value for disagreement.

Table 5.17: Perceptions on content and communication quality

Aspects of Content and Communication	N	Mean	Std. Deviation
It is efficient getting complete reading materials through the e-School system	749	2.7	1.019
The content retrieved from the e-School system is specific and relevant to the curriculum	743	2.9	0.913
Exchange of ideas with peers through e-mail has been efficient	751	2.3	1.191
The format quality of content in the e-School system has encouraged me to use the system	744	2.9	0.990
It has been possible to get materials from other e-Schools on time	745	2.2	1.080
Some teachers in my school participate in developing some content which is posted to the e-School system and shared with other e-schools	747	2.6	1.175
I have established friends through interconnection between my school and other e-Schools	746	2.1	1.160

A chi-square test of the means of the study population's perceptions of e-School content and communication quality revealed that all the means were statistically different from the expected means. This suggests that the perceptions are in agreement with the evaluative questions. However, some of the average levels of agreement with the statements were low, corroborating the earlier findings (see Tables 5.16 and 5.17) that the teachers' and students' views are mixed.

The reported perception on communication quality was probed with a question that solicited perceptions on the ease with which one could access the internet through e-School system. Most (72%) of the teachers and students asserted that they encountered difficulty when accessing the internet. A look at the responses across the e-Schools reveals that in virtually all the e-Schools, teachers and students encountered difficulty when accessing the internet. The number of teachers and students encountering difficulty with internet access was statistically different (chi-square value of 25.9 and p value of 0.000) from the number of those who were not encountering difficulty when responses were analyzed by schools. The difficulties encountered by students were not different from those encountered by teachers. An attempt to identify the differences in the responses of teachers and those of students revealed that there was no statistical difference, with a chi-square value of 0.373 and p value of 0.541. The principals of the e-Schools confirmed during the interviews that internet connectivity was available to both students and teachers when the e-School system was first installed. After the expiry of the consortia's contract to maintain the e-School system, internet connection was suspended. Other teachers and students attributed the difficulty of communication to network problems, limited access to the computer lab, obsolescence of the installed computers, and lack of knowledge on how to access and use the internet.

The content retrieved from the e-School system was highly rated by the students and teachers. A large number of respondents (67.6%) claimed that the content was of a higher quality than the content in textbooks. A small proportion (17.1%) was of the opinion that the quality of content retrieved from the e-School system is the same as the content in textbooks. Only 15.3% gave the opposing view that the content of the e-School system is not as good as the content in textbooks. Those who considered e-School content to be better than textbook content said that it is assistive in discovering scientific knowledge and supplementary to textbook content, and that it is easy to access and use such material. The majority of those who felt that e-School content is not as good as textbook content cited their poor computer efficacy and poor English proficiency. A large number (77.3%) of the respondents appreciated that e-School content is developed locally and can be updated when new information is discovered.

5.4.3 Service quality

Teachers and students were asked to rate the technical personnel's knowledge of their job, the personal attention they provide to users, how timeously they responded to calls for assistance, the adequacy of their services, their courteousness, and the quality of the maintenance they provide. As Tables 5.18 and 5.19 show, the first three questions addressed the service expectations of the teachers and students, the next three the perceptions of the service levels they were actually getting, and the last three questions were an overall evaluation of the technical staff.

Table 5.18: Service level expectations and perceived actual service as expressed by students

	Strongly Disagree	Disagree	Agree	Strongly Agree	Total	Total Agree	% Agree
IS technical staff should have knowledge of their jobs	59	44	264	321	688	585	85.0
IS technical staff should give users personal attention	44	113	271	262	690	533	77.2
When IS technical staff promise to fix a problem by a certain time they should do so.	108	137	245	197	687	442	64.3
IS technical staff have knowledge of their job	44	74	287	283	688	570	82.8
IS technical staff give users personal attention	91	163	229	190	673	419	62.3
When IS technical staff promised to fix a problem by a certain time they did so	138	164	218	161	681	379	55.7
I would rate the service quality qiven by technical personnel as adequate	87	148	313	131	679	444	65.4
The technical personnnel are pleasant to work with	47	125	295	219	686	514	74.9
E-School system is always kept in good working order	89	117	223	259	688	482	70.1

Table 5.19: Service level expectation and perceived actual service as expressed by teachers

	Strongly Disagree	Disagree	Agree	Strongly Agree	Total	Total Agree	% Agree
IS technical staff should have knowledge of their jobs	0	0	19	17	36	36	100.0
IS technical staff should give users personal attention	1	4	20	11	36	31	86.1
When IS technical staff promise to fix a problem by a certain time they should do so.	1	3	18	14	36	32	88.9
IS technical staff have knowledge of their job	0	4	15	16	35	31	88.6
IS technical staff should give users personal attention	1	3	19	12	35	31	88.6
When IS technical staff promise to fix a problem by a certain time they did so	2	5	19	10	36	29	80.6
I would rate the service quality qiven by technical personnel as adequate	1	8	18	9	36	27	75.0
The technical personnnel are pleasant to work with	1	4	21	10	36	31	86.1
E-School system is always kept in good working order	3	9	19	5	36	24	66.7

Teachers and students had high expectations of the technical service personnel. For example, 100% of the teachers expected the technical service personnel to be highly skilled and knowledgeable and 86.1% of the teachers expected them to give users personal attention. Students' levels of expectations were not different. Most of the students (85%) expected the technical service personnel to be knowledgeable and 77% of the students expected the personnel to give users personal attention. The perceived service levels were equally high, with more than 80% of the teachers agreeing that the service quality was high. While students' perception of actual service quality was high, it was relatively lower with respect to the personal attention provided (62.3%) and the timeliness of the personnel's responses to problems/ user requests (55.7%).

The essence of the servicequal instrument is to compare the corresponding responses for perceived service levels and expected levels of service quality. This could be analyzed by cross tabulating the perceived service levels against the expected levels of service. Such a procedure yields Tables 5.20, 5.21 and 5.22. The level of concurrence in agreement was high - 85.9% for the knowledge of work, 77.5% for giving attention to users, and 65.4% for timeliness.

Table 5.20: Agreement that IS staff members should be knowledgeable and they were

		IS technical staff have knowledge of their job				Total
		Strongly Disagree	Disagree	Agree	Strongly Agree	
IS technical staff should have knowledge of their jobs	Strongly Disagree	17	8	13	20	58
	Disagree	4	15	16	8	43
	Agree	3	29	173	74	279
	Strongly Agree	20	24	97	195	336
Total		44	76	299	297	716

Table 5.21 Agreement that IS staff should give users personal attention and did so

		IS technical staff give users personal attention				Total
		Strongly Disagree	Disagree	Agree	Strongly Agree	
IS technical staff should give users personal attention	Strongly Disagree	21	8	6	9	44
	Disagree	9	55	33	17	114
	Agree	24	64	136	54	278
	Strongly Agree	38	39	70	121	268
Total		92	166	245	201	704

Table 5.22: Agreement that when IS staff promised to fix a problem by a certain time, they did

		When IS technical staff promised to fixed a problem by a certain time they did so				Total
		Strongly Disagree	Disagree	Agree	Strongly Agree	
When IS technical staff promise to fix a problem by a certain time they should do so	Strongly Disagree	52	17	18	18	105
	Disagree	21	65	39	15	140
	Agree	30	41	129	55	255
	Strongly Agree	35	45	49	80	209
Total		138	168	235	168	709

Servicequal requires judgement on the difference between the perceived level of service and the expected level of service. It is assumed that there is a gap between the expected service level and the perceived service level. If the two were equal, then the mean of the differences would be zero. In the current study, the differences between the expected service levels and perceived service levels were computed and subjected to a student t-test to determine whether they were significantly different from zero. Table 5.23 presents the mean differences and Table 5.24 provides the test statistics.

Table 5.23: Mean differences in service level

Service Gap	N	Mean	Std. Deviation	Std. Error Mean
Gap in IS staff knowledge of the IS staff work	716	-0.061	1.043	0.0390
Gap in IS staff attention given to users	704	-0.305	1.156	0.0436
Gap in IS staff promptness to tackling user issues	709	-0.190	1.249	0.0469

Table 5.24: T-test statistics for mean differences in service level

Service Gap	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Gap in IS staff knowledge of their work	-1.5771	715	0.1152	-0.0615	-0.1380	0.0150
Gap in IS staff attention given to users	-7.0100	703	0.0000	-0.3054	-0.3909	-0.2199
Gap in IS staff promptness to tackling user issues	-4.0578	708	0.0001	-0.1904	-0.2825	-0.0983

The response to this particular question item was good, with 90% of the teachers and students offering their perceptions. On face value, the mean differences are close to zero (all have a magnitude below 0.5). The t-test, however, confirms a gap in IS personnel knowledge of their work as not statistically different from zero - $t = -1.577$ and $p = 0.115$, which is greater than the set p value of 0.05. This means that the IS staff actually showed the knowledge level that they were expected to possess. On the other hand, the gap in the attention IS staff gave to users and the gap in IS personnel promptness in responding to e-School users' issues were significantly different from zero. This implies that the attention that was given to e-School users and the promptness of IS personnel's responses to technical issues were below expectations.

Students and teachers were also asked to provide a summary evaluation of the quality of the service rendered by the IS technical personnel. A consistently high majority of respondents agreed or highly agreed that the quality of service of the IS personnel was adequate (65.4% students, 75% teachers), the technical personnel were pleasant (74.9% students, 86.1% teachers) and that the e-School system was always kept in good order (70.1% students, 86.1% teachers). The overall assessment on these three points was 2.892, which is high and significantly different from 2.0 as shown in Table 5.25.

Table 5.25: T-test of the overall assessment of technical personnel

	Test Value = 2					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
OVSERVQ*	34.047	712	.000	.8920	.8406	.9434

OVSERVQ* is the 'overall service quality

Teachers and students were asked to identify where the technical personnel should make improvements. Most respondents cited improving the maintenance of computers, assistance to students on a personal level, and professionalism. Other areas for improvement are presented in Table 5.26.

Table 5.26: List of areas for improvement

Description	No	Percentage
Keep computers in good working condition	81	14.6
Try to reach students on a personal level	72	13.0
Be professional	66	11.9
Introduce the internet, use of modems and flash disks	47	8.5
Timeliness in problem solving	45	8.1
Further training	41	7.4
Be more practical	38	6.8
More friendly to students and give adequate services	36	6.5
More textbooks and teachers	27	4.9
Motivate teachers and students to use e-learning	22	4.0
Always available	19	3.4
Allow access at all times	17	3.1
Further training on maintenance of infrastructure	13	2.3
Consider all students, not computer studies' students only	10	1.8
Allow leisure time with computers	5	0.9
Handle specific groups at a time	5	0.9
Allow students to engage in e-Schools contests	4	0.7
Increase work time	3	0.5
Introduce a register to ease control	3	0.5
Be conversant in English	1	0.2
Total	555	100.0

5.4.4 Training effectiveness of the teachers and students

This dimension of the e-School system sought to establish the extent to which the training conducted with teachers and students was effective in enhancing the use of e-School infrastructure. Attributes of training that were investigated include: variety of training methods, the training method that was widely used, the contribution of training to hands-on experience in computer use, role of training in changing attitudes towards computer use, and the need for additional training.

Most (76.9%) of the respondents concurred that during training, the trainers applied a variety of methods. This is depicted in the bar chart in Figure 5.7.

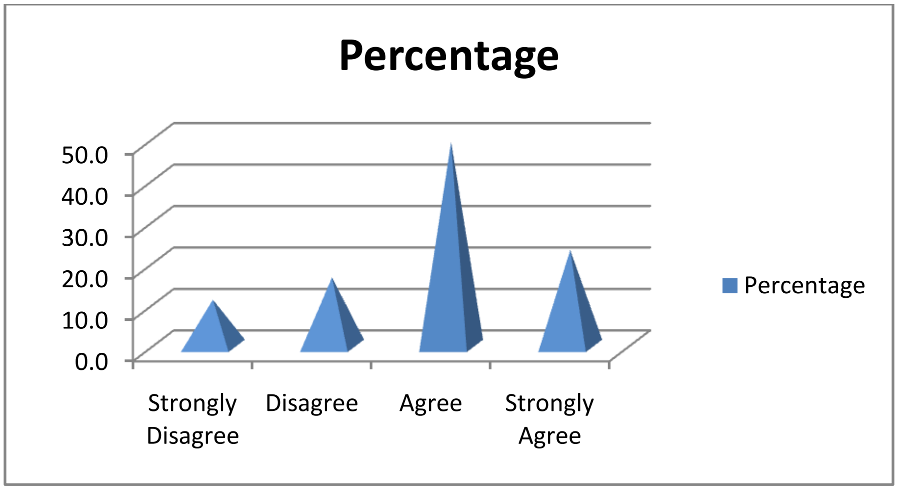

Figure 5.7: Perceptions on the variety of methods applied in training

The responses were homogeneous among students and teachers as shown in Table 5.27. Indeed, the distribution was almost identical, with 79.57% of the students and 83.7% of the teachers agreeing. The chi-square test reveals that the responses by students and teachers were not statistically different (chi-square = 3.0 and p = 0.388).

Table 5.27: Distribution of responses among students and teachers

			Student	Teacher	
	Strongly Disagree	Count	40	1	41
Training for e-School use gave me hands-on experience in the use of the computer system		Expected Count	39	2	41
	Disagree	Count	96	5	101
		Expected Count	96	5	101
	Agree	Count	294	13	307
		Expected Count	291	16	307
	Strongly Agree	Count	236	18	254
		Expected Count	241	13	254
Total		Count	666	37	703
		Expected Count	666	37	703

Response consistency on the variety of training methods was confirmed when over half of the respondents (51.5%) respondents disagreed in a follow up question item which portrayed lecture methods as having been the main method of training. In the training process, however, demonstrations took centre stage. Most of the respondents (62.6%) agreed with this assertion. Respondents appeared to gain from training as the majority (79.8%) acknowledged having attained hands-on experience in the use of computers. The majority of teachers and students (98.4%) also claimed that training encouraged them to use the e-School system. However, it was also revealed that a large proportion of respondents (88%) required additional training in the use of the e-School system. The students' responses were found to be statistically different from the responses of teachers, with a chi-square value of 12.512 and a corresponding p value of 0.006. A higher proportion of teachers (91.6%) required more training than students (87.8%).

Training was conducted largely within the school compound. The majority (90.2%) of teachers and students were trained within the school laboratory in the use of the NEPAD e-School. There was, however, a small percentage (3.9%) that trained outside the school compound. Of those who trained outside the school, three were teachers while eighteen were students. Eleven of the students and one teacher had not received any training in the use of computers.

Those who had received training agreed that their trainers appeared to have knowledge of the e-School system. Of the respondents, 86% indicated that the trainers had sound knowledge of computer skills. They justified their response with explanations that the trainers were able to respond to questions and could effectively demonstrate the use of the system. On the other hand, 14% were of the view that the trainers did not have good knowledge of the e-School system and complained that the trainers may not have been trained and did not have good practical skills. Nearly 50% of those who complained about the skills of the trainers had trained in other institutions outside the e-School.

Many of the teachers and students (62.2%) complained that the training period was inadequate. In some cases, training lasted only one day. Respondents also complained about the wastage of valuable time by the trainer, frequent power outages, and inadequate literature. Consequently, many concepts were not well understood by trainees. As a way to improve training, teachers and students suggested that the internet connection should be restored, those who did not benefit from initial training should be given additional training during school holidays, improvements should be made to teaching methods, and users should be given more time to practice.

5.4.5 E-School use

The study sought to gauge the use of e-Schools through three parameters: frequency of use, purpose of use, and exploitative or innovative use. Teachers and students were asked to indicate how often they interacted with the system, whether teachers incorporated the use of the e-School in classroom teaching, and the nature of the materials users accessed through the e-School.

5.4.5.1 Extent of use

Most of the students and teachers used the e-School system and a large proportion (79.6%) agreed that it is easy to use. The frequency with which the students and teachers used the system was also high among the majority (58.6%) of users. Analysis reveals that the proportion of teachers who agreed that e-School system is easy to use (82.1%) was not statistically higher than the number of students (79.4%) of the same view; the chi-square value was 0.996 with a p value of 0.802. The ease of use of the e-School system did not depend on where a user received training. Indeed, a very high majority (90.4%) of those who trained outside the e-School also found the system easy to use. This is further reinforced by a chi-square value of 32.6 and p value of 0.05, confirming that the ease of use between groups of users who trained in different places is not significantly different. Analysis by gender, however, revealed that the proportion of females (83.6%) who agreed was slightly higher than the proportion of males (74.5%), and this difference had a chi-square value of 11.24 and p value of 0.010, which makes the two groups statistically different. Females find e-Schools much easier to use. This corroborates statistical inference in this study that suggested that females were more interested than males in e-Schools.

When asked whether teachers incorporate the use of the e-School in classroom teaching, the majority (61.8%) of teachers and students disagreed that this was the case. Although slightly fewer teachers (53.8%) than students (62.3%) disagreed, the differences were of no significance with a chi-square value of 10.14 and a p value of 0.017. The responses elicited by this question are shown in Table 5.28.

Table 5.28: Perception that teachers incorporate use of e-School in classroom

Response	Frequency	Percent	Cumulative Percent
Strongly Disagree	251	32.3	34.6
Disagree	198	25.5	61.8
Agree	175	22.6	86.0
Strongly Agree	102	13.1	100.0
Total	726	93.6	

The level of disagreement, however, varied from one school to the next. Students and teachers from Chevakali High School expressed the lowest level of disagreement (45.2%), meaning that according to a small majority, teachers incorporated the use of the e-School in classroom teaching. The highest level of disagreement (83.7%) was expressed by teachers and students from Maranda High School. The assertion of teachers and students from Chevakali High School is understandable. It is only in this school that computers were installed in a computer laboratory and two other classrooms. This may suggest that installing computers in classrooms provide teachers with the opportunity to incorporate their use in teaching and learning. Table 5.29 shows the level of disagreement according to each school.

Table 5.29: Perception that teachers incorporate use of the e-School in classroom teaching

School	Strongly Disagree	Disagree	Agree	Strongly Agree	Total	Total Disagree	% Disagree
Chevakali Boys High School	30	27	50	19	126	57	45.2
Isiolo Girls High School	15	41	27	29	112	56	50.0
Maranda High School	61	26	13	4	104	87	83.7
Menengai Secondary School	51	43	24	10	128	94	73.4
Mumbi Girls	64	28	35	23	150	92	61.3
Wajir Girls	30	33	26	17	106	63	59.4
Average	251	198	175	102	726	449	61.8

The e-School system was designed with internet connections to enable users to access resources from within the LAN and WAN. The main objective is to support curriculum delivery. A significant number of respondents (59.2% of the students and 61.4% of the teachers) agreed that they used the e-School system to access additional material specific to the curriculum. From Table 5.3, it is evident that the means for most responses are above 2.0. However, some means are very close to 2.0. The means were subjected to a t-test to determine whether they were significantly different from 2.0. The mean responses for using the e-School to access lessons taught by teachers in other e-Schools and using the e-School to collaborate with peers were the only ones that were not statistically different from 2.0. This suggests that teachers' and students' access to the e-resources from other e-Schools and communication with peers in those e-Schools is very limited. This finding shows that the objective of encouraging students in e-Schools to practice self directed learning and to do collaborative work is not being achieved. The test statistics are presented in Table 5.31.

Table 5.30: Means of use attributes

Attribute of Use	N	Mean
The e-School system is easy to use	725	3.1
Students and teachers frequently use the e-School system	720	2.6
Teachers incorporate the use of the e-School system in classroom teaching	726	2.2
I use the e-School system to get additional material specific to the curriculum	720	2.6
I use the e-School system to get lessons taught in other e-Schools	725	2.1
I enjoy using the e-School system for learning purposes	722	3.0
I use the e-School system to collaborate with peers in other e-Schools	717	2.1
My teacher gives me additional exercises through the e-School system	703	2.2
I use content from the e-School system for independent learning	705	2.4
At times I access content which is not relevant to the curriculum from the e-School system	709	2.3
Some rules imposed by the school hinder the exploitative use of the e-School system	708	2.8
Valid N (listwise)	658	

Table 5.31: T-test for means being statistically different from 2.0

	t	Df	Sig. (2-tailed)	Mean Difference
I use the e-School system to get lessons taught in other e-schools	2.31	724	0.021	0.097
I use e-School system to collaborate with peers in other e-Schools	2.32	716	0.021	0.095

Test Value = 2.0; Confidence of interval of the means at 95%

5.4.5.2 Exploitative use

Students and teachers engage with the e-School for different reasons. A large proportion of users (53.2% of the students and 56.7% of the teachers) agreed that they used the e-School for independent learning. Less students (42.2%) and more teachers (57.6%) conceded that they accessed materials that were not relevant to the curriculum. The responses of the two groups - teachers and students - on this variable were significantly different with a chi-square value of 33.866 and p value of 0.000. A large majority (62%) of the respondents agreed that some rules imposed by the administration hindered their exploitative use of the e-School system. The rules hindered more students (62.7%) than teachers (45.2%). Barriers to users' exploitative use of the e-School include:

- Restricted access to the computer lab by non-computer studies students;
- Prohibition on the use of external drives like flash disks;
- Inadequate time to access the computer laboratory;
- Filtering of information that does not relate to education;
- Insistence on the removal of shoes before entering the computer laboratory;
- Lack of an internet connection;
- Students can only access the computer laboratory in the presence of teachers; and
- Too few computers and inadequate e-learning materials.

Some of these rules also account for lack of motivation to use the e-School system. Over half (67.4%) of the respondents claimed that they were not motivated to use the e-School system. Besides rules as a reason for lack of motivation, some users cited the low computer to user ratio, unavailability of teachers skilled or trained in the use of ICTs, and outdated learning materials. Those who felt motivated cited factors such as: the opportunity to create a global network of learners, exposure to new ideas, improved grades in examination, and simplified learning tasks.

5.4.6 E-School system user satisfaction

Students and teachers were asked to express their level of satisfaction with specific aspects of the e-School system. The teachers and students were also asked to give their overall rating of their satisfaction with the e-School system. Lastly, teachers and students were asked to list their complaints with respect to the e-School system.

5.4.6.1 Satisfaction with certain aspects of the e-School system

Teachers and students were asked to express their satisfaction with the sufficiency of content, specificity of the content, ease of use of the system, user friendliness of the e-School system, ability of the system to control individual learning pace, and effectiveness in sharing knowledge with the learning community. The means to these responses are shown in Table 5.32.

Table 5.32: User satisfaction with aspects of the e-School

Aspect of e-School	N	% valid responses	Mean
The e-School system provides content that exactly fits my needs	694	89.4	2.5
The e-School system provides sufficient content	684	88.1	2.6
The e-School system is easy to use	642	82.7	3.0
The e-School system makes it easy for me to find the content I need	664	85.6	2.8
The e-School system is user-friendly	676	87.1	3.0
The e-School system enables me to control my learning progress	649	83.6	2.7
The e-School system enables me to learn the content I need	674	86.9	2.8
The e-School system provides personalized learning support.	673	86.7	2.6
The e-School system makes it easy for me to discuss questions with my teachers/peers	667	86.0	2.5
The e-School system makes it easy for me to share what I learn with the learning community	675	87.0	2.5

All the responses to the level of satisfaction with specific aspects of the e-School system produced a mean of 2.5 and above. The level of agreement was in some cases as high as 3.0. These means were subjected to a t-test to ascertain whether they were all different from 2.0 (the upper limit for disagreement). The test revealed that all the means were statistically different from 2.0 (see Table 5.33) which confirms that users were satisfied with the stated aspect of the e-School system. There was consistency in the responses. For example, the two aspects that relate to ease of use but which were phrased differently scored an identical mean of 3.0.

Table 5.33: T-test for mean satisfaction with specific aspects of the e-School

	Test Value = 2					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
The e-School system provides content that exactly fits my needs	12.017	693	.000	.47	.39	.55
The e-School system provides sufficient content	15.865	683	.000	.61	.53	.68
The e-School system is easy to use	27.025	641	.000	.95	.89	1.02
The e-School system makes it easy for me to find the content I need	20.050	663	.000	.78	.71	.86
The e-School system is user-friendly	29.058	675	.000	1.01	.94	1.08
The e-School system enables me to control my learning progress	17.662	648	.000	.70	.62	.78
The e-School system enables me to learn the content I need	20.527	673	.000	.80	.73	.88
The e-School system provides personalized learning support	14.917	672	.000	.61	.53	.69
The e-school system makes it easy for me to discuss questions with my teachers or peers	12.073	666	.000	.50	.42	.58
The e-learning system makes it easy for me to share what I learn with the learning community	11.067	674	.000	.47	.39	.55

Discriminant analysis was conducted to establish which of the two groups (teachers or students) was satisfied with different aspects of user satisfaction. Students' extent of satisfaction with the e-School is shown in Table 5.34. The most satisfying aspect of the e-School in the opinion of students was user friendliness (76.25%) followed by ease of use (74.75%). The least satisfying aspects were suitability of content (48.86%) and sharing knowledge with the learning community (49.38%).

Table 5.34: Students satisfaction with e-School

Aspect of e-School	Highly disagree	Disagree	Agree	Highly agree	Total	Total Agree	% Agree
The e-School system provides content that exactly fits my needs	145	191	193	128	657	321	48.86
The e-School system provides sufficient content	114	158	242	136	650	378	58.15
The e-School system is easy to use	54	99	272	181	606	453	74.75
The e-School system makes it easy for me to find the content I need	88	138	220	183	629	403	64.07
The e-School system is user-friendly	53	99	266	222	640	488	76.25
The e-School system enables me to control my learning progress	102	126	245	147	620	392	63.23
The e-School system enables me to learn the content I need	96	120	238	190	644	428	66.46
The e-School system provides personalized learning support	133	139	212	154	638	366	57.37
The e-School system makes it easy for me to discuss questions with my teachers/peers	148	172	178	142	640	320	50.00
The e-School system makes it easy for me to share what I learn with the learning community	165	161	170	148	644	318	49.38

Teachers' satisfaction with the e-School followed a similar trend, as shown in Table 5.35. The most satisfying aspect was ease of use, which was supported by 80.56% of the teachers. This was followed by content of interest (70%). The least satisfying aspects of the e-School in the opinion of teachers were sufficiency of content (44.12%) and control of the learning process (51.72%). This data suggests that the e-Schools were designed to support students' learning more than teachers' learning.

Table 5.35: Teachers satisfaction with the e-School

Aspect of e-School	Highly disagree	Disagree	Agree	Highly agree	Total	Total Agree	% Agree
The e-School system provides content that exactly fits my needs	4	11	18	4	37	22	59.46
The e-School system provides sufficient content	5	14	10	5	34	15	44.12
The e-School system is easy to use	2	5	23	6	36	29	80.56
The e-School system makes it easy for me to find the content I need	5	7	18	5	35	23	65.71
The e-School system is user-friendly	2	9	20	5	36	25	69.44
The e-School system enables me to control my learning progress	5	9	9	6	29	15	51.72
The e-School system enables me to learn the content I need	5	4	17	4	30	21	70.00
The e-School system provides personalized learning support	6	5	18	6	35	24	68.57
The e-School system makes it easy for me to discuss questions with my teachers/peers	4	5	11	7	27	18	66.67
The e-School system makes it easy for me to share what I learn with the learning community	6	8	13	4	31	17	54.84

5.4.6.2 Overall satisfaction with the e-School system

Teachers and students were asked to rate evaluative statements on their overall satisfaction with the e-Schools. One question item asked the teachers and students to declare their perceived satisfaction with the e-School system. 47.2% were satisfied with the e-School system. Of the respondents satisfied with the e-School system, the proportion of teachers (52.7%) was slightly higher than the proportion of students (46.8%), but the two proportions were found not to be statistically different with a chi-square value of 3.5 and corresponding p value of 0.32. Although the proportion of students and teachers who were satisfied was slightly lower than those who were not satisfied, the mean response was 2.48, which is statistically different from 2.0 when subjected to a t-test. This may suggest that overall, teachers and students were satisfied with the e-School, but only weakly.

A similar trend was observed in the other two question items on overall satisfaction. Over half (60.2%) of the respondents perceived the e-School system to be a success. The mean response to this question was 2.7, which is statistically different from 2.0. The last question on overall success sought to determine whether respondents were satisfied with the health content in the e-School system. Over half of the respondents (52.7%) agreed that the health information in the e-School system was informative. The corresponding mean response was 2.66 which is statistically different from 2.0. The responses of teachers were not statistically different from the responses of students. The responses to the three questions on satisfaction are shown in Table 5.36. Table 5.37 shows the corresponding chi-square test output.

Table 5.36: Perceived satisfaction with the e-School system

Response	Satisfied with e-School	E-School is a Success	Informative Health Point
Strongly Disagree	23.4	16.5	15.9
Disagree	29.4	23.2	25.6
Agree	23.5	34.3	34.9
Strongly Agree	23.7	26.0	23.6
Total	100	100	100

Table 5.37: Chi-square test of teachers' and students' responses

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.504(a)	3	.320
Likelihood Ratio	3.583	3	.310
Linear-by-Linear Association	.374	1	.541
N of Valid Cases	680		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.42.

5.4.6.3 Complaints about the e-School

To further address perceived satisfaction levels with the e-School system, teachers and students were asked to list the complaints they had with respect to the e-School system. The majority (76.4%) had something to complain about. The most frequent complaint was inadequate infrastructure (10.6%) followed by poor maintenance of the system (9.6%) and unreliable internet (9.4%). Virus infection was registered as a complaint by 7.6% of the respondents. Other complaints registered by respondents are listed in Table 5.38. Unreliable internet connection, poor maintenance and access rights also featured as unresolved issues in all the interviews with the principals. Many of these complaints relate to inadequate financing of the e-School system.

Table 5.38: List of complaints about the e-School system

Complaint	Frequency	Percentage
Infrastructure inadequacy	63	10.6
Computer problems and maintenance	57	9.6
Unreliable internet	56	9.4
Time to the use system	54	9.1
Inadequate trainers	52	8.8
Inadequate materials and information	49	8.3
Slow system	48	8.1
Viruses	45	7.6
Power interruptions	37	6.2
Biased authorization to access to the lab	35	5.9
Small size of the lab	23	3.9
Rules and conditions not favourable	22	3.7
System not easy to use	21	3.5
Lack of protection for eyes from rays	16	2.7
Insufficient funding for maintenance and supplies	7	1.2
Unstable network	6	1.0
Addiction by some students	1	0.2
Lack of interest	1	0.2
Total	593	

5.4.7 E-School net benefits

The net benefits of the e-School system were investigated through question items which could be clustered into five categories: public perception of the e-School system, improved students academic performance, lifelong learning, resource management, and teamwork. The respondents were also presented with open-ended questions to give them the opportunity to identify benefits which had not been contemplated.

5.4.7.1 Public perception of the e-School

Teachers and students were asked to indicate whether parents would prefer the e-Schools over non e-Schools. A large majority agreed that parents viewed the e-Schools more favourably than non e-Schools as shown in Table 5.39. The mean response was 2.98 which is statistically different from 2.0, confirming that teachers and students actually agreed. The proportion of students (69.5%) who agreed was much higher than the number of teachers (44.4%) who agreed. The difference in the responses of students and teachers was, however, not statistically different with a chi-square value of 6.997 and p value of 0.072.

Table 5.39: Parents perceived preference for e-Schools over non-e-Schools

Response	Frequency	Valid Percent	Cumulative Percent
Strongly Disagree	111	16.8	16.8
Disagree	82	12.4	29.3
Agree	172	26.1	55.4
Strongly Agree	294	44.6	100
Total	659	100	

5.4.7.2 Improved academic performance

Teachers and students were presented with three question items that related to improved academic performance. The questions sought to establish whether resources in the e-School system helped students perform better, made learning and teaching more enjoyable, encouraged independent learning, and improved the understanding of lessons. All three question items recorded a high level of agreement. The majority (85.7%) of the respondents agreed that using the e-School system made teaching and learning more enjoyable. The proportion that agreed that resources in the e-School help students perform better was 63.6%, and those who agreed that their understanding of a lesson improved when they reviewed lesson topics from e-School content was also high (62.6%).

The mean responses for all the question items were higher than 3.0, as shown in Table 5.40, and all the means were statistically different from 2.0, as shown in the t-test in Table 5.41. In the latter, all the p values = 0.000 which is less than the set value of 0.05.

Table 5.40: Mean responses on the academic impact of e-Schools on performance

	N	Mean	Std. Deviation	Std. Error Mean
Infrastructure/resources in e-Schools help students perform better	662	3.06	0.9535	0.0371
Teaching and learning in the e-School is more enjoyable	665	3.28	0.8754	0.0339
My understanding of a lesson normally improves when I review the topic from e-School content	657	3.00	1.0098	0.0394

Table 5.41: T-test of the means, value = 2.0

	t	Df	Sig. (2-tailed)	Mean Difference	95% Confidence	
					Lower	Upper
Infrastructure/resources in e-Schools help students perform better	28.493	661	0.000	1.056	0.983	1.129
Teaching and learning in the e-School is more enjoyable	37.786	664	0.000	1.283	1.216	1.349
My understanding of a lesson normally improves when I review the topic from e-School content	25.266	656	0.000	0.995	0.918	1.073

A follow-up document analysis was conducted on the performance of the e-Schools from 2005 (when e-School was launched in Kenya) to 2010. Performance was analyzed according to the schools' overall performance indices and the performance indices in languages (Kiswahili and English). Changes in the performance indices are shown in Figures 5.8, 5.9 and 5.10. Figure 5.8 reveals that overall performance indices improved in Maranda High School, Chevakali High School and Mumbi Girls Secondary School. The performance index for Menegai Secondary School remained almost steady from 2005 to 2010, while the performances of Isiolo Girls Secondary School and Wajir Girls Secondary School dropped over the study period.

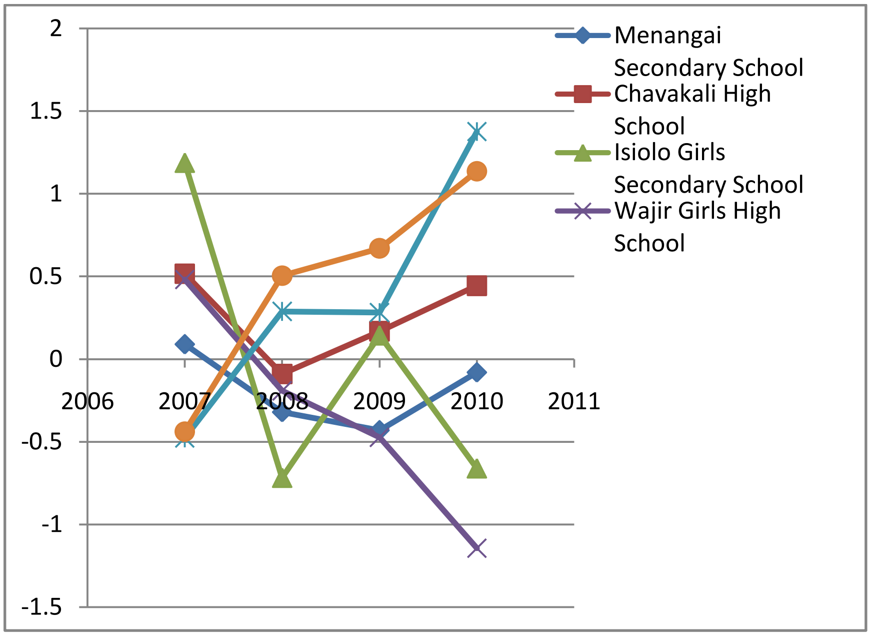

Figure 5.8: Changes in overall school performance

There were improvements in the students' performance in English in Maranda High School, Chevakali High School and Mumbi Girls Secondary School. Menengai High School showed a small improvement. Decline in performance in English was recorded in Isiolo Girls Secondary School and Wajir Girls Secondary School. Figure 5.9 shows the trend in changes in the performance indices of the e-Schools in English.

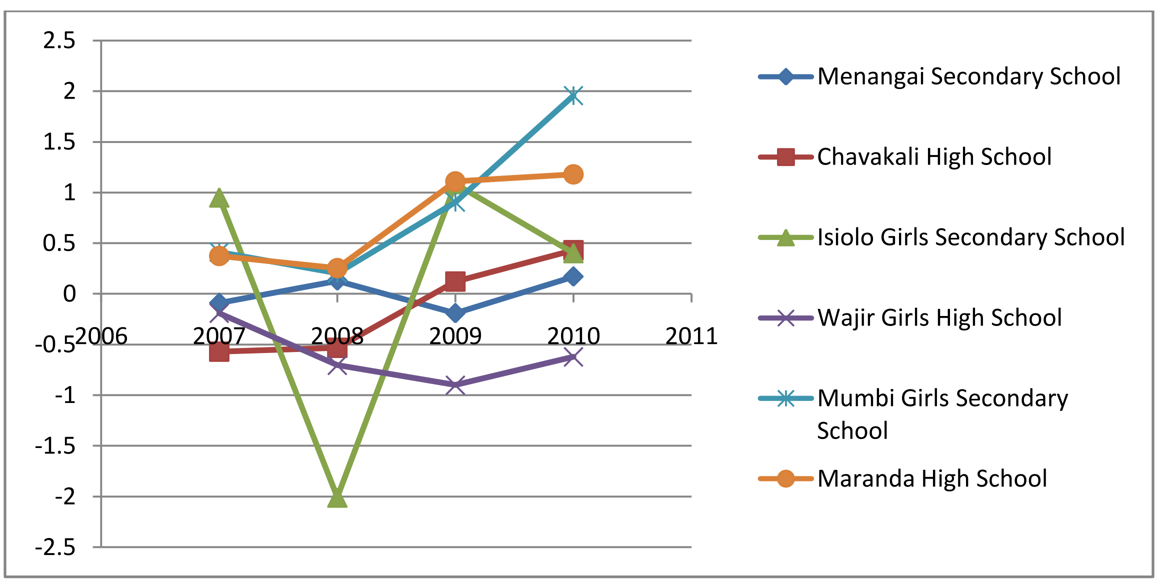

Figure 5.9: Changes in performances in English

Trend analysis was also conducted on the performance indices for Kiswahili (an examinable language in Kenya). There was a remarkable improvement in the performance indices for Kiswahili in Maranda High School, Chevakali High School and Mumbi Girls Secondary School. The performance index for Menengai High School remained more or less steady. A drop in performance indices was recorded in Isiolo Girls Secondary School and Wajir Girls Secondary School. The trend in performance in the Kiswahili language is shown in Figure 5.10.

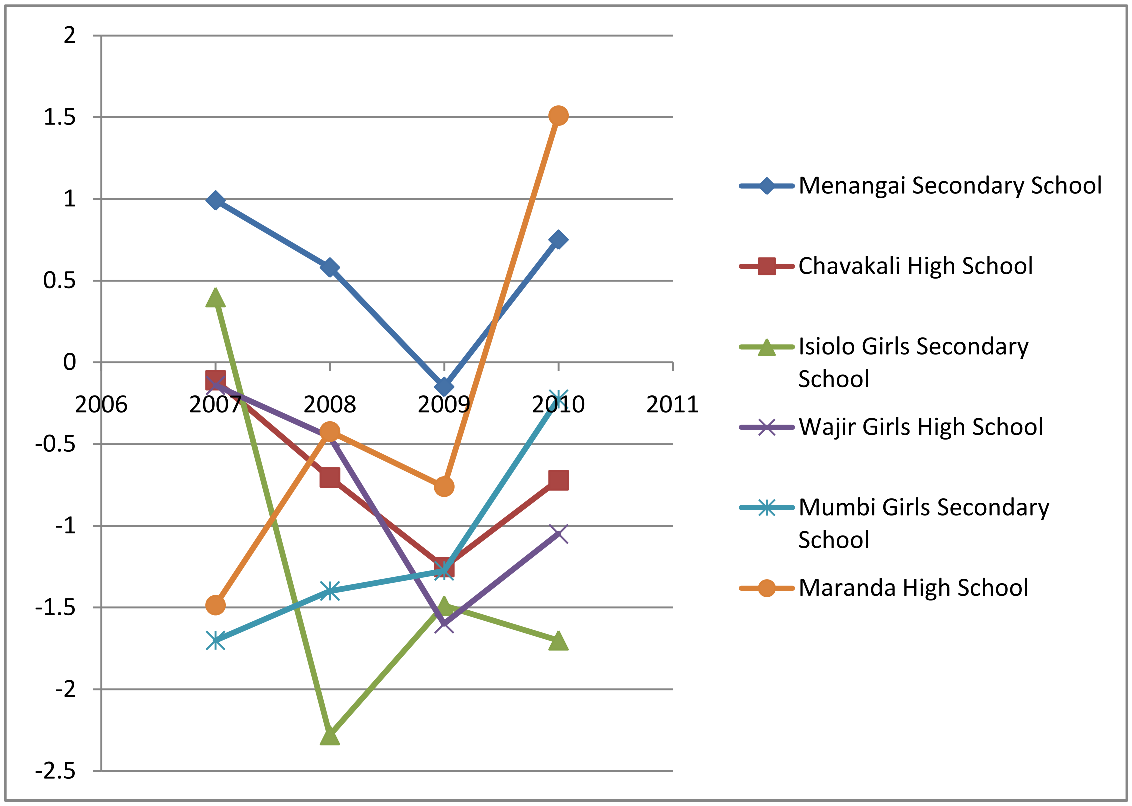

Figure 5.10: Changes in performances in Kiswahili

From data derived from a document analysis of e-School changes in performance, it is evident that students' perceptions of the positive impact of the e-School system on performance are corroborated with actual performance records in four cases. The exceptions are Isiolo Girls Secondary School and Wajir Girls Secondary School.

5.4.7.3 Teamwork skills

Teamwork skills are attained through collaboration with peers either locally or through networks. Teachers and students were asked to indicate whether the use of the e-School system facilitated collaboration between teachers and students in different schools and whether their teamwork skills had improved since they started using the e-School system to communicate. Responses were grouped into two for each case. The first group consisted of students and teachers who had disagreed with the assertion that the exchange of ideas between peers in different schools is efficient and the second group consisted of students and teachers who had agreed that the exchange of ideas was efficient between peers in different schools. Similar grouping was done for students and teachers who had agreed/disagreed with the assertion that the use of the e-School had facilitated the establishment of friends across schools. Every group was analyzed according to their perceptions of teamwork skills. Table 5.42 shows cross tabulation on the efficiency of the exchange of ideas against the improvement of teamwork skills arising from the use of the e-School system.

Table 5.42: Exchange of ideas against teamwork skills

Exchange of ideas with peers through e-mail has been efficient		My teamwork skills have improved since I started using the e-School communication system				Analysis		
		Strongly Disagree	Disagree	Agree	Strongly Agree	Total	Total Agree	% Agree
Strongly Disagree	Student	38	45	67	80	230	147	63.9
	Teacher	1	1	2	1	5	3	60.0
	Sub-Total	39	46	69	81	235	150	63.8
Disagree	Student	17	29	36	21	103	57	55.3
	Teacher	2	1	2	2	7	4	57.1
	Sub-Total	19	30	38	23	110	61	55.5
Agree	Student	11	18	49	56	134	105	78.4
	Teacher	0	0	7	1	8	8	100.0
	Sub-Total	11	18	56	57	142	113	79.6
Strongly Agree	Student	13	27	50	61	151	111	73.5
	Teacher	1	1	1	2	5	3	60.0
	Sub-Total	14	28	51	63	156	114	73.1

As shown in Table 5.42, 63.9% of the students and 60% of the teachers strongly disagreed with the assertion that the exchange of ideas with peers through e-mail is efficient. These students and teachers, however, gets opportunities to use e-School communication system and acknowledge that they have experienced improvement in teamwork skills. More students (73.5%) than teachers (60%)

who strongly agreed that exchange of ideas with peers through e-mail is efficient, confirmed that using the e-School communication system improved their teamwork skills.

The responses of teachers and students on the establishment of friends through e-mail and the effect of the e-School communication system on teamwork skills are shown in Table 5.43.

Table 5.43: Establishment of friends through e-mail against the improvement of teamwork skills

I have established friends through network connections between my school and other e-Schools		My teamwork skills has improved since I started using the e-School communication system				Analysis		
		Strongly Disagree	Disagree	Agree	Strongly Agree	Total	Total Agree	% Agree
Strongly Disagree	Student	54	54	85	93	286	178	62.2
	Teacher	1	1	0	0	2	0	0.0
	Sub-total	55	55	85	93	288	178	61.8
Disagree	Student	14	31	43	28	116	71	61.2
	Teacher	0	1	2	2	5	4	80.0
	Sub-total	14	32	45	30	121	75	62.0
Agree	Student	7	21	43	38	109	81	74.3
	Teacher	0	0	9	3	12	12	100.0
	Sub-total	7	21	52	41	121	93	76.9
Strongly Agree	Student	4	13	30	58	105	88	83.8
	Teacher	3	1	1	1	6	2	33.3
	Sub-total	7	14	31	59	111	90	81.1

Over half of the students (61.2%) and the majority of the teachers (80%) who disagreed with the assertion that they had made friends through network connections with other e-Schools had experienced improvement in teamwork skills. On the other hand, a very large majority of students (74.4%) and teachers (100%) who agreed that they had established friends through network connections with other e-Schools experienced improvement in teamwork skills. Networking was possible within each e-School and between e-Schools. The former require working LAN that is available in all e-School while the later require WAN which was not always available due to inefficient internet connection.

The findings reported in Tables 5.42 and 5.43 suggest that students were able to access the internet through the e-Schools even when the VSATs were not working. Interviews with the principals of the schools revealed that the schools' administration and teachers accessed the internet through CDMA modems. This dial-up connection could also be achieved through the server and in effect allow all e-School users within the LAN to access internet. CDMA is an abbreviation for 'collision detection multiple access', which is a communication protocol. In the words of one principal: "The teachers may at times organise for students to access the internet from the e-School laboratories during computer lessons." Arrangements for e-Schools to access the internet through CDMA modems are initiatives of the management of the individual e-Schools and the schools meet the cost of maintenance.

5.4.7.4 Lifelong learning

Teachers and students were presented with one question on lifelong learning. The majority (69.2%) agreed that the e-School system encouraged them to practice independent learning. The frequency distribution of the responses is shown in Figure 5.10. The proportion of teachers (70.8%) who reported practicing independent learning was higher than the proportion of students (66.5%). The responses of the two groups were not statistically different with a chi-square value of 4.421 and probability of 0.219. The mean response of 2.9 was statistically different from 2.0 with a t-test value of 23.42 and p value of 0.000.

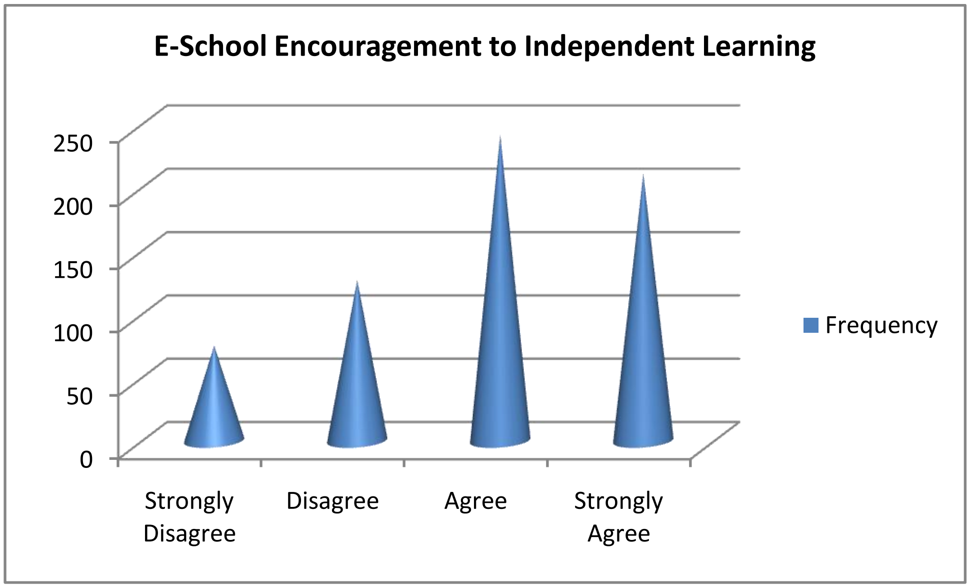

Figure 5.10: Frequency distribution of those encouraged to attempt independent learning

The proportion of females (70.5%) who agreed that the e-School system encouraged them to attempt independent learning was higher than the proportion of males (67.4%), but the proportions were not statistically different with a chi-square value of 8.028 and p value of 0.045.

5.4.7.5 Efficient use of resources

The e-School system is used for both learning and management. Users were presented with a question asking them to rate their perceptions on whether e-School infrastructure assists with the efficient use of resources. A large majority of the users (76.5%) agreed that the installation of the e-School system helps in the efficient use of resources, as shown in Table 5.44. The mean response of 3.03 was found to be statistically different from 2.0 with a t value of 28.334 and p value of 0.000.

Table 5.44: Perceived contribution of the e-School system to the efficient use of resources

Response	Frequency	Valid Percent	Cumulative Percent
Strongly Disagree	61	9.3	9.3
Disagree	94	14.3	23.5
Agree	268	40.7	64.2
Strongly Agree	236	35.8	100.0
Total	659	100	

The perception that the e-School assists with the efficient use of resources was stronger (81.5%) among teachers than among students (73.1%), but the responses were not statistically different with a chi-square value of 2.6 and p value of 0.457.

5.4.7.6 Other benefits of the e-School system

Teachers and students were asked to list other benefits of the e-School system. A large percentage (93.6%) of the teachers and students offered their thoughts on the benefits of the e-School. The suggestions were varied, with a total of 14 different possible benefits mentioned. The most commonly perceived benefit was gaining computer literacy (25.4%), followed by making and connecting with new friends (14.7%). Other benefits cited by a sizeable proportion of teachers and students were: improved understanding of the subject (11.3%), quicker, enjoyable and easier learning (8.9%), accessing information from other sources (8.8%), and interaction with other schools (8.8%). Only one person (a student at Chevakali High School) cited identifying possible job opportunities as a benefit. The frequency distribution of responses on benefits of the e-School system is shown in Figure 5.11.

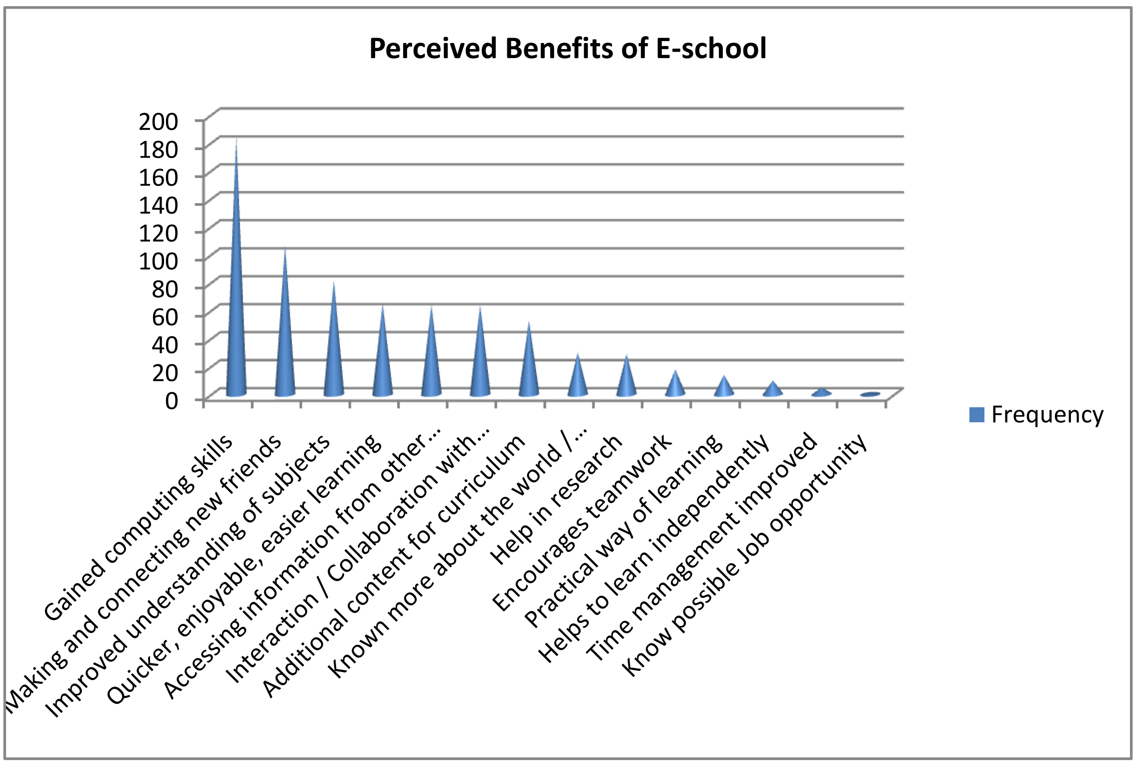

Figure 5.11: Perceived benefits of the e-School

5.5 Summary

This chapter has made a presentation and analysis of the data. The chapter began with an analysis to validate the instrument used in evaluating the success of the NEPAD e-School initiative. A split half method for exploratory and confirmatory factor analysis was undertaken to confirm stability in the data set. This was then followed by an analysis of consistency and an analysis of response characteristics. Finally, an analysis into the success of the e-School system was conducted. In the analysis, the following main findings were made:

1. The study's research instruments stood the test of reliability and validity. Data was found to be stable in the split half method of explorative and confirmatory factor analysis and demonstrated high reliability, with six of the dimensions recording an alpha value of 0.7 and above, except for the training effectiveness dimension which recorded an alpha value of 0.48;
2. Construct validity was established through factor analysis. Seven factors with many measurement items loaded to them were established, and these were in line with the seven dimensions conceptualised theoretically;
3. The study achieved a high response rate of 51.4%, which is high when compared to the response rate of similar studies in literature;
4. The infrastructure quality of NEPAD's pilot e-Schools was found to be acceptable to the majority of teachers and students in all the schools in Kenya;
5. Some aspects of information content and communication quality were unacceptable while others were satisfactory. The quality of content and its suitability to the curriculum was acceptable to 72.4% of the teachers and students. However, quality of communication was unacceptable to 60.7% of the teachers and students;
6. The service quality of the technical personnel was found to be acceptable to teachers and students. 85.9% perceived the knowledge of service personnel to be very good and 77.5% of the teachers and students considered the attention given to users to be appropriate. The service personnel were also rated highly by 65.4% of the teachers and students on their timeous service. However, while the technical personnel showed the knowledge of ICT as expected of them, there was statistically significant gap in the service quality with respect to the attention technical personnel gave to users and the timeous response to users' issues;

7. The training appeared to be effective, with 51.5% agreeing on the variety of methods applied and 78% claiming to have gained hands-on experience. However, a large majority (88%) of the respondents required additional training;
8. The use of the e-School system has achieved some level of success. For example, 79.6% of the respondents found the system easy to use and 58.6% used the system frequently. The extent to which the system was used is supportive of the curriculum as 59.4% used it to access additional material. The system was also used exploitatively for independent learning by 53.3% of the teachers and students. The integration of the e-School system in classroom teaching was, however, lacking, as confirmed by 61.8% of the respondents. Rules impeding exploitative use were also attested to by 62% of the teachers and students;
9. User satisfaction with the e-School was high. All aspects of the e-School reflected above produced a mean satisfaction level of 2.5 (in a scale of 1 to 4). A sizeable proportion of 47.2% agreed that overall, they were satisfied with the e-School system. 52.7% were satisfied with the health content of the e-School system. But up to 76.4% had at least one complaint to raise about the system;
10. The e-School offers numerous benefits. The e-School was viewed favourably by parents, attested to by 69.5% of the students. 85.7% of the said that it makes learning enjoyable. 63.6% of the teachers and students felt that it improves student performance and 62.6% believed that it improves the understanding of lessons. The e-School was perceived to facilitate some collaboration by 48.1% of the respondents and impart teamwork skills in the view of 54.8% of the respondents. It was also believed to contribute to lifelong learning in the view of 69.2% of the respondents and the efficient deployment of resources in the view of 76.5%.

The next chapter discusses these findings in relation to similar studies in literature and reported general practice.

CHAPTER SIX

DISCUSSION OF FINDINGS

6.1 Introduction

The evaluation of NEPAD's pilot e-Schools in Kenya was designed to establish the extent to which the e-School is succeeding and to identify challenges and find ways of addressing these challenges in order to improve the success rate of the e-Schools during the full roll-out of the programme. The study was motivated by, among other issues, the need to improve access to education, justify the massive investment in infrastructure for ICT integration in teaching and learning, inform the full roll-out of the NEPAD e-School programme to assure maximum gains, and extend knowledge in the evaluation of information systems. This study used the E-School Success Model, which is a re-specified version of DeLone and McLean's (2003) IS Success Model, as its theoretical framework. While DeLone and McLean's (2003) IS Success Model has been widely applied in IS evaluation, its use in the evaluation of e-Schools has not been reported.

The study re-specified DeLone and McLean's (2003) IS Success Model in order to adapt it to the evaluation of e-Schools. As in DeLone and McLean's (2003) IS Success Model, the E-School Success Model has seven dimensions. The seven dimensions of the E-School Success Model were clustered under the five objectives of the study. Analysis of data was performed to establish the extent to which each of the seven dimensions was successful. Consequently, the study's findings are discussed under the five objectives of this evaluation of NEPAD's pilot e-Schools in Kenya.

In discussing the findings in relation to the literature review on the subject, this chapter raises issues that inform the conclusion and recommendations of the study. The chapter begins with a discussion of the reliability and validity of the data collected and confirms its suitability for making inferences and conclusions. Next, it discusses findings in the study in relation to the study's objectives. Finally, the interpretation of the findings are laid out and compared to the findings in similar studies, and possible reasons for unexpected findings are explained.

6.1.1 Reliability and validity of the study's research instruments

This study used the survey method, with a manageable sample whose results should be generalizable onto the target population. To achieve this, the study's hypotheses were well articulated and the data collection instruments thoroughly designed in order to help capture reliable and valid data (Blumer & Warwick, 1993). In a study of this kind, it is paramount to ensure that the data gathered is as objective as possible and a relatively accurate representation of the underlying phenomenon (Straub, Boudreau & Gefen, 2004). To enhance the quality of the collected data, careful planning and execution of the study right from the conceptualization stage was ensured as advised in (Pallant, 2007).

The study's instruments stood the test of reliability and validity. The data proved to be consistent when tested using the split-half method of explorative and confirmatory factor analysis. Cronbach's alpha for the two sets of data produced a linear graph which shows consistency and therefore high reliability. With the exception of the training effectiveness dimension which recorded an alpha value of 0.48, six dimensions of the E-School Success Model recorded high validity with alpha values of 0.7 and above (Andrew, Pedersen & McEvoy, 2011). Nunally (1978) pinned the lowest correlation co-efficient between a factor and variables as 0.300. Other studies (Gefen, Straub & Boudreau, 2000) consider Cronbach's alpha of 0.400 for factor loading as adequate in exploratory studies in IS. The alpha value of 0.48 for the 'training effectiveness' dimension therefore meets the validity criteria of IS studies. Thus inferences coul be made on the target population of NEPAD e-schools. Minimum requirements for generalization were taken into account at the design stage of the study. Specifically, the design ensured that a representative sample (30% or N=1,508) was selected that was suitable for factor analysis. According to MacCallum, Widaman, Zhang and Hong (1999), for a study whose variable to factor ratio (r:p) is 20:7 or higher, a sample size of 400 and above is excellent. In this study, the ration of r:p was 85:7. The representativeness of the sample was also enhanced by implementing probabilistic procedures during sampling (De Vaus, 2002). While the study's findings should be infered onto all the e-Schools in Kenya, this may be extended to other African countries participating in the pilot of NEPAD e-Schools since they implemented largely similar systems with the same objectives.

6.1.2 Response rate

The study highlighted the importance of the response rate. Survey response rate is the percentage of eligible respondents who were measured and the non-response rate is the complement (Groves, Fowler, Couper, Lepkowski & Singer, 2009). To reduce the error associated with non-response, steps were taken to improve the response rate as a way of improving the quality of the study and particularly making it appropriate for generalization. Specifically, arrangements were made for face-to-face meeting with respondents (Stoop, Billiet, Koch & Fitzgerald, 2010). A few respondents were interviewed and questionnaires were delivered in person to those respondents who were not being interviewed. Consequently, an impressive response rate of 51.4% was realized.

Researchers have not agreed on an acceptable minimum response rate in a survey. The effect non-response has on quality of findings is also not specific as it depends on how the statistics of non-respondents relates to those of respondents**.** In general however, a higher response rate lowers the risks of non-response error. The response rate in this study was high enough to ward off the risks of non-response. In exploratory studies such as this one, a response rate of 5% is deemed adequate (Van Iwaarden, Van der Wiele, Ball & Millen, 2004: 952). For non exploratory studies, if the questionnaire is long, a response rate of 30% is reasonable (Leitheise, 1992: 75). Many studies have reported much lower response rates than 30% (Groves, Fowler, Couper, Lepkowski & Singer, 2009). A similar study that distributed the questionnaire by e-mail achieved a 23.7% response rate (Barry, Lang, Wojtokowski, & Wojtkowski, 2008). Other reported rates are 41% (Rocheleau, 2006), 8.1% (Piattini, 2000), and 56% (Van De Walle, Turoff, Hiltz, 2010). A few surveys in IS have, however, recorded much higher response rates, for example 85% for Armoni (2002) and 75% for Aberer, Peng, Rundensteiner, Zhang, & Li (2006). In either set of studies, the results were reported to be valid.

6.2 Achievements of the NEPAD e-School

This study explored the achievements of NEPAD’s pilot e-Schools in Kenya by testing seven hypotheses in the evaluation of five objectives. These five objectives were: determining the success of the installed ICT infrastructure in enhancing teaching and learning, establishing the effectiveness of the training imparted on users, assessing the use to which the e-School is put, identifying the level of user satisfaction, and establishing the benefits accruing from the e-School.

6.2.1 Objective 1: Establishing the ICT infrastructure installed in the NEPAD e-Schools and determining the infrastructure's quality, accessibility and suitability for enhancing teaching and learning

This objective was investigated using the following three sets of hypotheses:

$H1_1$: The quality of the installed e-School infrastructure (the IS) determines the level of success of the e-School.

$H1_o$: The quality of the installed e-School infrastructure (the IS) does not determine the level of success of the e-School.

$H2_1$: The quality of information content and communication contributes to the level of success of the e-School.

$H2_0$: The quality of information content and communication does not contribute to the level of success of the e-School.

$H\ 3_1$: High service quality offered by the technical personnel contributes to the success of the e-School.

$H3_0$: High service quality offered by the technical personnel does not contribute to the success of the e-School.

6.2.1.1 Contribution of installed ICT infrastructure to e-School success

The implementation of e-Schools requires enabling infrastructure. The infrastructure should enable resource development, access, and communication in a variety of channels. Ideal infrastructure would include multimedia computers with online access, design software, scanners, printers, digital video projectors, digital TV and smart screens, among other components (Leask & Pachler, 1999).

Multimedia computers are essential because content for blended learning comes in a variety of forms and the teachers in particular are expected to develop content for sharing. Teachers may be expected to work offline when there is no internet connection in their homes. The availability of compact disks (CD) makes it possible for teachers to migrate data between their home workstations and the school system. Multimedia resources such as video, animations and simulations have the capacity to better explain dynamic concepts and motivate students (Green & Brown, 2002).

In most of the e-Schools, computers were mainly situated in the computer laboratories without additional points of access in the staff rooms or principals' offices. Part of the reason for this inadequate distribution of access points was the star network infrastructure deployed. In a star network, smart monitors are connected directly to servers and the system has limited transmission power of point-to-point links between the central node and the peripheral nodes. This explanation accounts for the hitherto low preference for star topology (Lee, Lee, Son & Yoo, 2005). Peripheral nodes which are located beyond the maximum transmission distance have to be linked through repeaters to boost computing power (Bhatia & Bhatia, 2009). If the location of computer labs is too far from teachers' offices, fiber optic 10Base-FL (fiber link) and transceivers are required to complete connections (Mathivanan, 2007). Fiber optic cables are quite costly to implement and their maintenance requires a high level of technical know-how. Expansion of star topology beyond the computer laboratories is therefore not an immediate option for the e-Schools. Within a school compound, wireless networks can be a cost effective and flexible solution for teachers and students with handheld computing equipment (Singh & Bukar, 2007).

While the infrastructure quality of the NEPAD e-Schools was acceptable to the majority of respondents in all the schools, it did have its shortcomings. The student to computer ratio was very uneven, and there were only a few number of computer laboratories (between one and three). This makes it difficult for students to adequately access the available technologies. This finding corroborates a study conducted in the Western Cape region in South Africa where academic staff in higher education institutions complained about limited access to ICTs for teaching due to lack of on-campus facilities, lack of integration between on-campus and off-campus systems, and poor institutional support for e-learning (Czerniewicz & Brown, 2006). The e-School system is generally adopted to increase access to education and improve the quality of teaching and learning (Evoh, 2007). Access to infrastructure and its suitability would therefore naturally determine the success of the e-School. Access to the e-School should be open to students during class hours and after class hours. After class hours, students should be encouraged to attempt independent learning and provided with the opportunity to be coached by their teachers online and at individual level.

Some studies (Barret, Rainer & Marczyk, 2005) have found that students place more emphasis on independent learning, yet it is mainly those students who engage in online sessions who perform better in formal examinations, making the findings inconclusive (Graff, 2005). Either way, the opportunity to develop independent learners is lost in all the e-Schools as computer laboratories may not be accessed after class hours.

The chi-square observed values for all the items in the test were above the minimum expected value of 5 with a significance level of 0.000, which is less than the set p value of 0.05. These results support the rejection of the null hypothesis, confirming that the quality of the installed infrastructure is suitable and is positively contributing to e-School success.

6.2.1.2 Contribution of information content and communication quality to e-School success

The study established that some aspects of information content and communication quality of the e-School system were unacceptable to the users while others were satisfactory. The quality of content and its suitability to the curriculum was acceptable to 72.4% of the respondents. However, the quality of communication was unacceptable to 60.7% of the respondents. The quality of content of the NEPAD e-School system positively contributes to its success. This is corroborated in the findings of a study in the United States on adult learners' perceptions of instructional quality, in which 86% of the respondents indicated that the most important aspect of instructional quality of online courses was content and instructional material that is relevant to the course (Kidd & Song, 2007). NEPAD's inclusion of the internet connection through VSAT was deliberate to facilitate connectivity between the e-Schools and access to external resources. The unacceptable quality of communication is a source of frustration and a cause for students to abandon the use of the system.

This is supported by an evaluation of online learning in Australia, where Finger (2007) found that students strongly favoured the use of telephone teaching over HF radio because telephone communication was much clearer and students could hear all the things said by their teachers.

Poor communication in NEPAD's e-Schools means that major goals of the e-School system, including teamwork and lifelong learning (Duta, 1999; Ya'Acob, Nor & Azman, 2005; Condie & Livingston, 2007), may not be realized in the current setup of the programme. The internet connection was severed soon after the private sector development partners, who were tasked with the design and implementation of e-School infrastructure, handed over the project to the Ministry of Education. The explanation offered for the disconnection was the inability of the Ministry of Education to afford the costs of connection.

According to Ashcroft & Watts (2005), the cost of internet access in developing countries tends to be high, and this may account for the inability of the Ministry of Education to continue to source funds for maintaining internet access in the e-Schools. Organizations reduce access costs by pooling resources and subscribing access through an umbrella body. For example, Kenyan universities' access to ICT has been greatly facilitated by the Kenya Educational Network Trust (Adam, 2003). The Kenya Educational Network Trust (KENET) is a non-profit organization that provides internet access to tertiary institutions in Kenya. NEPAD's e-Africa Commission took on a similar role but in support of secondary schools. The organization negotiated access to the internet through the Regional African Satellite Communication Organization (RASCOM) which launched into orbit on the 21st of December 2007. RASCOM is specifically dedicated for use in rural Africa. RASCOM provides state-of-the-art facilities which allow users to pay for minutes to use telephony services and the internet in a variety of ways, including the use of scratch cards. It would be in the interest of NEPAD e-Schools' success for the Ministry of Education in Kenya to pool the access requirements of the e-Schools and purchase, as a bundle, satellite access time from RASCOM in order to re-distribute it to the e-Schools.

Chi-square statistics revealed that all the observed frequencies were above the expected minimum, and all the items had a p value of 0.000 which is less than the set value of 0.05 resulting in the rejection of null hypothesis. This therefore means that information content and communication quality is positively contributing to e-School success.

6.2.1.3 Contribution of service quality to e-School success

This study measured service quality as a way of assessing the value of the e-School's services to the user community (Remenyi & Money, 1994). Service quality measures customers' relationship with the organization, making it a strategic tool for marketing the institution and its products **(**Hope & Cady 2000). In information systems, service quality has been found to contribute considerably to user satisfaction (Saha, Nath & Salehi-Sagari, 2010; Wang, Wang & Shee, 2007) and by extension IS success. The service quality of technical personnel in this study was found to be acceptable to teachers and students. For example, 85.9% of the users perceived the knowledge of service personnel to be very good and 77.5% of the teachers and students considered the attention given to users as appropriate. The service personnel were also rated highly by 65.4% of respondents on their timeous service. Analysis reveals that technical personnel's knowledge loading to the service quality dimension was 0.57, but this explains only 5% of the variability of the dependent variable. This compares favourably with findings in other studies. For example, Liu and Arnett (2000:63) studied the factors associated with website success in the context of electronic commerce among Fortune 2000 companies in the USA. In their study, quick responsiveness to customers (timeliness) produced a high loading value of 0.63, and the assurance that customers' problems will be solved (knowledge of the job) had an even higher loading of 0.73 in the information and service quality dimension. In another study on the success of data warehousing in the USA, Wixom and Watson (2001) identified the skills of employees as explaining 44% of data warehousing success.

The relatively low rating of technical personnel's timeous service mirrors Hope and Cody's (2000) study of extranet service quality in New Zealand where, of the five dimensions of service quality, employee responsiveness was rated the lowest. While the respondents in the current study believed that the technical personnel demonstrated the knowledge of ICTs as expected of them, there was a statistically significant gap in the service quality with respect to the attention technical personnel gave to users and the timeliness with which the technical personnel responded to users' issues. As with other studies, exceeding consumer expectations is challenging because consumer expectations are difficult to define and are less stable (Kelemen, 2003:13). According to Kahn, Strong and Wang (2002), consumer expectations change over time as tasks change and general expectations of computing capabilities and services rise up. Mills (2002) posits that IS staff members have some level of control over the three sources from which customers draw expectations: word-of-mouth, IS-communication and past experiences. In reality however, these controls are limited in e-Schools. For example, IS staff members may not have the time to educate users and influence their experiences, part of which occurs as users interact with IS experts from other institutions. The veracity of the service quality of technical personnel in estimating the success of the e-School therefore remains undisputed, and the trend established in the current study indicates that NEPAD's pilot e-Schools are succeeding with respect to this dimension. The chi-square observed values for all the items in the test were above the minimum expected value of 5 and the significance levels were all 0.000, which is less than the set p value of 0.05. Overall, the results confirm that the service quality of technical personnel is positively contributing to e-School success.

6.2.2 Objective 2: Determine the effectiveness of the training imparted on teachers and students to enable them to constructively engage with the installed ICT infrastructure in teaching and learning

The achievement of objective 2 was discussed by using the following set of hypotheses:

$H4_1$: Effective training method and approach contributes to the success of the e-School.

$H\ 4_0$: Effective training method and approach does not contribute to the success of the e-School.

6.2.2.1 Contribution of the effectiveness of the training of teachers and learners to e-School success

All the end-users of e-Schools in educational institutions (lecturers, students and staff) require effective training as a way to increase their intention to use the information system (Amaoko-Gyampah & Salam, 2004), shape user attitudes, and probably influence the acceptance of the e-

School system. A study by Adeyinka (2009) on the course content management system at the University of Botswana underscored the contribution of training or its lack thereof to IS success. Training teachers and students was identified by the e-Africa Commission as one of the critical objectives of the pilot of NEPAD's e-Schools. In this study, training effectiveness was viewed as important for the success of the e-School as it motivates use. Training quality was found to be effective, with 51.5% of the teachers and students agreeing on the variety of methods applied. A large proportion of users (78%) confirmed that they attained hands-on experience through training. Overall, hands-on experience had a relatively high loading (0.744) in the training effectiveness dimension. Attainment of hands-on experience is critical in science studies, as reported in Parham's (2003) evaluation of computer science education. This is also supported by a study on the development of instructional strategy in Taiwan where students suggested that they need more time to practice during instruction (Lee, 2001). Continued sessions of practical learning tend to reinforce expertise.

An action study conducted in the USA designed to increase women engineering students' belief in their academic abilities revealed that hands-on experience increased the women students' computer self-efficacy (Shull & Weiner, 2002). The action research exposed the students to repeated demonstrations and reinforcement of proficiency in computer-related tasks. In the present study, a large majority (88%) of the respondents expressed the need for additional training. A higher number of teachers (91.6%) required more training than students (87.8%). Teachers' training for ICT integration in teaching and learning can be divided into two components: ICT technical skills and appropriate pedagogies for blended learning. As will be emphasized later, it was revealed that teachers did not incorporate the use of ICTs in the classroom. The inability of teachers to use ICTs in the classroom is partly as a result of the training provided and partly due to limited computing resources. This confirms the findings in other studies that teachers concentrate on the development of ICT technical skills (see Tondeur, Braak & Valcke, 2007) but fail to use or improve the use of available infrastructure in classrooms (Ward, 2003). In order for teachers to productively use ICTs in the classroom, issues of the availability of infrastructure, technical competence of the teacher, teachers' readiness, and teachers' pedagogical skills, must be addressed.

Many of the teachers and students (62.2%) complained that the training period was inadequate. As a way to improve training, teachers and students suggested that: the internet connection should be restored; those who did not benefit from initial training should be given additional training opportunities during school holidays; improvements should be made to teaching methods; and more time should be set aside for users to practice. According to Bhattacherjee and Premkumar (2004), there is often interplay between changes in attitude and users' level of satisfaction with the IS. Those users who have positive experiences with computer based training (CBT) increase their positive attitudes towards the IS, while those who have negative experiences with CBT appear to develop more negative attitudes towards IS (Bhattacherjee & Premkumar, 2004:246). Beas and Salanova (2006) suggest that training does not influence the attitude toward computers directly, but through interaction of number of training hours on a specified target group for example ICT professional in whom training increases self-confidence in their profession (p.1054). This is true for those who already have a positive attitude towards training at the beginning of training. It is therefore beneficial to expose trainees to more hours of computer use to increase the success of the IS. The chi-square value for the effectiveness of training showed a significant level of confidence and therefore the null hypothesis was rejected, confirming that training effectiveness positively contributes to e-School success.

6.2.3 Objective 3: Establishing the extent to which e-School infrastructure is being used to enhance teaching and learning and provide health information

This objective was discussed to establish whether:

$H5_1$: High and exploitative usage of the e-School system contributes towards the success of the e-School.

$H5_0$: High and exploitative usage of the e-School system does not contribute towards the success of the e-School.

6.2.3.1 Contribution of e-School use to its success

Actual use of an information system has been found to be closely tied to the success of the IS. Devaraj and Kohli (2003) evaluated the impact of the use of a hospital system on revenue collection and measured actual use from computer time longitudinally, and established that high utilization corresponded with increased hospital revenue. Most studies, as in the current study, rely on users' reported use of IS due to the difficulties associated with observing and measuring actual use. Observations in the computer laboratories confirmed that the NEPAD e-School system was in use at the time of the study. Some 79.6% of the respondents found the system easy to use, but only 58.6% of the respondents used the system frequently. However, the loading of these variables in the use dimension was inverted, with ease of use scoring 0.495 and frequency of use 0.635. The e-School system is being used to support curriculum delivery; 59.4% of the students and teachers confirmed that they used it to get additional material. The system was also being used exploitatively for independent learning by 53.3% of the teachers and students.

Most of the teachers and students (61.8%) disagreed with the statement that teachers incorporate ICTs in their teaching in the classroom. From observation, it was established that in most e-Schools, computer hardware was installed in computer laboratories. Many classes therefore could not access laboratories for most of the teaching. The integration of ICT in the curriculum becomes effective when ICT infrastructure is widely accessible, particularly in classrooms. This would enable the teachers to use the facilities for teaching and to give students assignments that may be marked online. Furthermore, it is only when facilities are widely distributed that students get the opportunity to use them effectively. Limitations in the distribution of ICT facilities could be attributed to inadequate funding (Özdemir & Kılıç, 2007; Jhurree, 2007). Insufficient funding was listed by the interviewed principals as one of the main problems bedeviling the e-School.

The current study's findings confirm the results of earlier studies. While reviewing the integration of ICT in secondary schools in New Zealand, Ward (2003) established that despite the wide availability of ICT infrastructure in the classrooms and the training imparted on teachers, ICT was only rarely used in classroom teaching. In the study by Ward (2003) the mean frequency of use was 2.01 on a scale of 1-'minimum' to 4 - 'maximum', which is almost replicated in this study where the mean frequency of use was 2.2 on a scale of 1 – 'highly disagree' to 4 – 'highly agree'. In the schools in New Zealand, the use of ICTs for ideas and information scored a mean of 2.49 which compares favourably with the mean of 2.4 in NEPAD's pilot e-Schools; learning to work collaboratively scored a mean of 2.1 (with a loading of 0.835) in New Zealand but a relatively high mean of 3.0 (with a loading of 0.666) in NEPAD's e-Schools. The high alpha factor in the New Zealand study suggests that the data was more reliable than the data generated from the NEPAD e-Schools. However, the critical issue is that the availability of infrastructure and training are not sufficient conditions for the integration of ICT in curriculum delivery. Integration of ICT requires teachers to receive more training in multi-media uses, publishing on the web, and pedagogies that relate to student-centered teaching/ inquiry-based learning. The success of integrative use also demands a reasonable level of user support (service quality) and motivation for lifelong learning.

Pedagogical approaches to ICT integration in curricula are known to have wide ranging effects (Yuen, Law & Wong, 2003). Such pedagogies are different from the usual pedagogical practices that traditional teachers are used to (Ya'Acob, Nor & Azman, 2005). The integration of ICT in curricula requires a pedagogy of student-centered teaching, inquiry-based learning and reflective assessment, which have been found to improve students' meta-cognitive thinking strategies (So & Kim, 2009). Teachers in the sampled e-Schools had not been exposed to pedagogical skills for ICT integration, and a large majority (88%) who required additional training should have pedagogy introduced as part of their training.

As a predictor of e-School success, the use of the NEPAD e-School is succeeding. The chi-square values for all the variables had acceptable significance levels below the set p value of 0.05. The null hypothesis was rejected, implying that e-School use positively contributes to the success of the e-School. The e-School's implementers should, however, take heed of the concerns of users and increase access, impart additional skills on teachers, and identify effective methods of motivating teachers so that they can appreciate the intrinsic value of frequently integrating ICT in classroom teaching.

6.2.4 Objective 4: Determining the extent to which e-School users (students and teachers) believe the e-Schools prepare students to function in the global economy

This objective was discussed using the following set of propositions:

$H6_1$: High level of satisfaction of teachers and students with the e-School system (all aspects including system quality, content and communication quality, use, and exploitation and training) contributes to the success of the e-School system.

$H6_0$: High level of satisfaction of teachers and students with the e-School system (all aspects including system quality, content and communication quality, use, and exploitation and training) does not contribute to the success of the e-School system.

6.2.4.1 Contribution of user satisfaction with the e-School to e-School success

Users' satisfaction with the e-School appeared to be high. All aspects of satisfaction with the e-School reflected mean levels that were above 2.5. A slightly smaller proportion of 47.2% agreed that overall, they were satisfied with the e-School. 52.7% were satisfied with the health content in the e-School. However, up to 76.4% had at least one complaint to raise about the e-School. This suggests that users' satisfaction varies, and user satisfaction may only be partly contributing positively to e-School success. Ruben, Emans, Leinonen, Skarmata and Simons' (2005) study of the design of a web-based collaborative learning environment confirms this finding. The study posits that the non-involvement of users may result in the lack of shared objectives between the users and implementers. The implementation of the NEPAD e-School was a top-down directive from the Ministry of Education after signing a Memorandum of Understanding (MoU) with the NEPAD e-Africa Commission and ICT development partners. Students admitted that they did not necessarily select to join the e-Schools based on information of the ICT infrastructure and their induction is always conducted without an ICT needs assessment survey.

Satisfaction with ICT integration in teaching and learning may be influenced by: the availability of resources, perceived ability to use ICTs, having the basic skills to operate ICTs (Bingimlas, 2009), the availability of relevant content, and positive outcomes of use such as improved student performance (Wenet, Olliges & Delicath, 2000). These influencing factors converge in Bhattecharjee’s (2001) description of user satisfaction. According to Bhattecharjee (2001), user satisfaction is an affect captured as a positive, indifferent or negative feeling. Similarly in Chin and Lee’s (2000) definition, user satisfaction is the overall affective evaluation the user has with respect to his or her experience in relation to the information system. It therefore translates into an evaluation of all facets of the information system, and as posited in other studies, is a close estimator of IS success. The current study revealed that user satisfaction is not contributing to the success of the e-School in some variables.

The chi-square test revealed that three variables could prevent the rejection of the null hypothesis. The ability of the e-School to facilitate discussion between students, their peers and teachers produced a low chi-square value of 6.793 and a p value of 0.079; sharing what students learn with the learning community registered a chi-square value of 2.896 and a p value of 0.408; and overall satisfaction with the e-School registered a chi-square value of 7.071 and a p value of 0.070. The degree of freedom for each of the variables was 3, and therefore the critical chi-square value expected was 7.82 with a p value less than 0.05 for the null hypothesis to be unequivocally rejected. The remaining ten (10) variables met the necessary conditions for rejection of the null hypothesis. Studies in economics (see for example Zivot & Andrew, 1992) have weighed the strength of evidence supporting the rejection of hypotheses against strengths dissuading rejection. Such studies concur that when there are more factors supporting rejection than those dissuading rejection, the null hypothesis may be rejected. In the current study, 23% of the chi-square values dissuaded the rejection of the null hypothesis. Furthermore one of the three variables that dissuaded rejection of the null hypothesis bears summative evaluation of the user satisfaction dimension. It is therefore consistent results failed to reject the null hypothesis. The implementers of e-Schools need to address the concerns raised in the failed variables, i.e. to ensure that students’ communication with peers in other e-Schools and the sharing of ideas within the learning community is enhanced. This is achievable through the improvement of the communication system, especially by making internet services widely available.

6.2.5 Objective 5: Establishing the extent to which the e-School improves the efficiency of school management and the processes of teaching and learning

Objective 5 is discussed in relation to the following set of hypotheses:

$H7_1$: Net benefits of IS contributes to the success of the e-School system.

$H7_0$: Net benefits of IS does not contribute to the success of the e-School system.

6.2.5.1 Contribution of e-School net benefits to e-School success

The e-School has numerous benefits. Use of the e-School was found to improve the users' understanding of lessons. Some 62.6% of the respondents appreciated that the integration of ICT in teaching and learning makes it easier to understand concepts. In a study conducted in Scottish secondary and primary schools, teachers acknowledged that by integrating ICT in teaching and learning, one come to learn one concept from different perspectives (William, Coles, Wilson, Richardson & Tuson, 2000). The study also established that teachers who understood and enjoyed the benefits of ICT integration used the systems more. When students and teachers use the e-School system, they are provided with opportunities to easily interrogate the system in order to access a variety of information sources on the same subject matter**.** This also encourages independent learning - a student, having understood a concept taught in class, could easily search for more information and read ahead of the teacher.

The study also revealed that most parents (69.5%) preferred e-Schools over non e-Schools and therefore had a positive attitude towards the e-Schools. This corresponds with findings in a survey in Alabama which investigated teachers', students' and parents' attitudes towards the integration of technology in classroom teaching. Aleciou-Ray, Wilson, Wright and Peirano (2003) established that most stakeholders had a positive attitude towards technology integration. More than 57% of the parents in that study expressed satisfaction with the content of class websites. Factors contributing to this positive attitude included easy access to homework assignments and test dates, and the retrieval of make-up work for their children. Access to this kind of information makes it possible for parents to closely monitor the progress of their children which should result in improved academic reports. Academic reports should also improve because students find learning enjoyable, as attested to by 85.7% of the students in that study (i.e. Aleciou-Ray, Wilson, Wright and Peirano, 2003) and by virtue of parents supporting the integration of ICT.

In the Kenyan situation, parents perhaps view the use of ICTs in schools as a 'fashion' that puts e-Schools above the rest. Modern schools are also associated with the endowment of resources that should improve student performance, as perceived by 63.6% of the respondents. An analysis of the e-Schools' performance reveals that of the six e-Schools, four had experienced improvement in academic performance. Improvement was documented in overall performance and performances in English and Kiswahili. Two e-Schools, however, showed a decline in performance in the languages and overall.

Other studies have also reported mixed results. According to Eng (2005:648), a review of research in ICT integration in teaching and learning confirms that there is a small positive impact on students' performance and a few instances of negative impact. A controlled experiment with a group of students in Canadian secondary and primary schools also produced mixed results. The treatment group that was taught with the integration of ICTs showed an improved performance in the English language. However, the control group of students who had no access to ICT integration in the classroom outperformed the treatment group in mathematics (Sclater, Sicoly, Abrami & Wadde, 2006). Such findings are inconclusive and should therefore be interpreted with caution.

The e-Schools weakly facilitated collaboration for 48.1% of the respondents, and imparted some teamwork skills in the view of 45.2% of the respondents. This is consistent with the results of a study on the role of ICT as a promoter of students' cooperation. Schulz-Zander, Buchter and Dalmer (2002) confirmed that well integrated ICT improved collaboration between students and teachers. Collaboration can be within the school or with peers and teachers outside the school. Schulz-Zander, Buchter and Dalmer (2002) found that as a result of collaboration, students acquired competencies that made them coaches to both peers and teachers in their specialties, which was true even for students whose academic competency was rated below average. Collaboration between people connected as friends through the internet is fulfilling as collaborators obtain knowledge from a variety of sources and different perspectives. The enjoyment students derive from learning with technology is taken a level higher as they collaborate, resulting in improved knowledge development and creation.

The contribution of ICTs to collaboration and teamwork skills has been proven in various studies. Dori, Tal and Peled (2002) found that teachers who used web-based teaching showed a tendency to collaborate more with their peers and to develop a new teaching approach in their careers. Indeed, arising from the benefits they reap from collaboration with their peers, teachers become inclined to encourage students to adopt the use of e-School as a platform to draw support from both students and teachers. In an e-School, teachers adopt an interactive pedagogy in supporting their students online (Tchombe, Maiga, Toure, Mbangwana, Diarra & Karsenti, 2008). As they obtain online support, students tend to develop inquiry-based learning which in turn prepares them for higher education. Tchombe, Maiga, Toure, Mbangwana, Diarra, and Karsenti (2008) underscore the pedagogical integration of ICT in teaching as the fulcrum to accruing benefits of using ICT in teaching and learning.

Inquiry-based learning has been beneficial in some situations. It is most effective in learning in medical schools where the curricula is built around finding solutions to problems (Sandoval, 2005; Albanese & Mitchell, 1993). Mixed results have, however, been obtained in other studies on the impact of inquiry-based learning. For example, in a study to compare the critical thinking abilities of two groups of students, Loiis, Dianne and Joanne (2002) found that those students who scored lowest in critical thinking tests initially benefited from inquiry-based learning as opposed to students who obtained middle and higher scores. At a lower level of education (secondary level), much fewer studies have been conducted on the impact of inquiry-based learning (Hmelo-Silver, 2004). Preparation for inquiry-based learning is time consuming and therefore requires teachers to have lower workloads. The intensified use of such methodology should also be cautiously implemented and mainly restricted to science-based subjects because most of the existing syllabi for secondary education in Kenya do not facilitate inquiry-based learning and its real benefits are not proven.

This study concurs with the results of previous studies that the integration of ICT in curriculum delivery empowers students with some teamwork skills and abilities for lifelong learning (Ya'Acob, Nor & Azman, 2005; Condie & Livingston, 2007). Caution should however be taken to guide the implementation process to avoid instances that may impede success. For example, a teacher in Liu's (2007) study promised her class that she would to integrate the use of the wireless learning environment to support student-centered pedagogy but instead persistently continued with the he traditional teacher-centered approach. Students subsequently developed a negative attitude towards the use of the technology. It is therefore important that when integrating ICT in education, adequate training should be provided to help teachers embrace the new pedagogy and change their approach to teaching without unrealistically raising expectations.

Overall, the net-benefits of the e-School system are largely contributing towards the success of the system. Chi-square values for all the variables were high and were significantly higher than the expected values, resulting in a rejection of the null hypothesis. Interestingly, enjoyment of learning through the e-School system scored the highest chi-square (362) followed by preference of the e-School by parents (160.8). Enhancement of teamwork and collaboration reflected relatively lower chi-square values of 89.238 and 53.14 respectively. These are the same variables that recorded the lowest level of satisfaction. Their low values could be traced to restricted internet access which should facilitate connection between peers and institutions. It is imperative for internet access to be sustained in e-Schools to enhance e-School success.

6.3 Summary

Chapter six discussed the findings of the current study in relation to the results in similar studies in literature and attempted to explain possible disparities. The discussion pointed to the contributions of most of the dimensions of the e-School towards the success of the e-School. Through data mining, all the null hypotheses except the sixth were rejected with high chi-square values. The sixth null hypothesis stated that, "*High level of satisfaction of teachers and students with the e-School system (all aspects including system quality, content and communication quality, use, and exploitation and training) does not contribute to the success of the e-School system*." Some variables (23%) that measured the user satisfaction dimension did not get the minimum threshold level of agreement of teachers and students. The weighted contribution of the three variables was low and therefore could not influence the rejection of the null hypothesis. Issues discussed in this chapter point to the conclusion and recommendations that are proposed in the next chapter.

CHAPTER SEVEN

SUMMARY, CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

The main objective of this study was to undertake an empirical evaluation of the success of NEPAD's pilot e-Schools in Kenya. The specific objectives of the study were to:

1. Establish the ICT infrastructure installed in NEPAD's pilot e-Schools in Kenya and determine the infrastructure's quality, accessibility and suitability for enhancing teaching and learning;
2. Determine the effectiveness of the training imparted on teachers and students to enable them to constructively engage with the installed ICT infrastructure in teaching and learning;
3. Establish the extent to which e-School infrastructure is being used to enhance teaching and learning and provide health information;
4. Determine the extent to which e-School users (students and teachers) believe the e-Schools are preparing students to function in the global economy; and
5. Establish the extent to which the e-School improves the efficiency of school management and the processes of teaching and learning.

The study population consisted of six e-Schools and the teachers and students in these e-Schools. The population of teachers and students in the e-Schools amounted to 5,186. A representative sample of 1,508 students and teachers was selected using probabilistic techniques. Data was collected using a variety of methods - installed infrastructure was recorded using an observation schedule, e-School principals' insights into the progress and impact of the system were collected using structured interviews, and students' and teachers' perceptions were collected using a self-administered questionnaire. Document analysis was also conducted on the performances of the e-School in national examinations with the aim of corroborating teachers' and students' perceptions of their schools' performances in examinations.

This chapter provides a summary of the study's findings, the conclusions of the study, and recommendations that may inform theory, policy, practice, and future studies.

7.2 Summary of findings

This section presents the summary of the findings under each of the five objectives of the study. The summary is subsequently used to derive conclusions and propose recommendations.

7.2.1 Objective 1: Establishing the ICT infrastructure installed in the NEPAD e-Schools and determining the infrastructure's quality, accessibility and suitability for enhancing teaching and learning

In working towards this objective, the study tested the following three hypotheses:

- Hypothesis1: The quality of the installed e-School infrastructure (the IS) determines the level of success of the e-School;
- Hypothesis 2: The quality of information content and communication contributes to the level of success of the e-School; and
- Hypothesis 3: High service quality offered by the technical personnel contributes to the success of the e-School.

7.2.1.1 Hypothesis1: The quality of the installed e-School infrastructure (the IS) determines the level of success of the e-School

Data collected through observation revealed that all six of the e-Schools had installed the requisite infrastructure for integrating ICT in teaching and learning. This infrastructure included computer laboratories fitted with computer workstations, computer servers, local area networks (LANs), computer printers, smart television sets, smart boards, LCD projectors for displaying information, VSAT for satellite links, and power sources with back-up generators in some of the e-Schools. The computers were installed only in computer laboratories in all the schools except Chevakali High School where a few computers were installed in some classrooms. This arrangement restricted access to computers in the e-Schools as students could only access the computer laboratories of a few number of times in a week and only during scheduled lessons.

The restricted access to e-School resources makes it difficult to integrate ICT in teaching and learning (Sa´nchez, Salinas & Harris, 2011). In an ideal situation, teachers should use information and communication technology as a teaching platform in everyday classroom teaching. This was not possible in these e-Schools as ICT infrastructure had not been extended to the classrooms. Such limitations are not unique to the pilot of NEPAD's e-Schools. Other e-School programmes, for example the Malaysian Smart Schools, the SCHOLAR's programme of the United Kingdom, and the Enlaces programme of Chile, all rely heavily on the use of computer laboratories (Hinostroza, Labbe, Brun & Matamala, 2011; Beacham, 2011; Hamzah, Ismail & Embi, 2009). Students should interact with peers and teachers after class or during recess. It is during this time that teachers could coach individual students on lower or higher level tasks depending on the individual student's capacity. Such arrangements would only be possible if there are large laboratories open to students all the time or if workstations are distributed to the classrooms.

The workstations were in good working order. However, in all the e-Schools, the VSATs had been disconnected from the satellite link due to non-subscription. As a result, access to the internet was restricted for scheduled lessons as it was achieved throughdial-up connections through the main server. It provided students with access during class teaching mainly. Students who were in school before the year 2009 (one year before data collection) enjoyed access to the internet because at the time, VSAT connections were still live. Those students had therefore experienced interacting with peers and even teachers online. Online interactions are cardinal to the achievement of the overall objective of the e-School, particularly because it enhances exploitation of e-School resources (Sife, Lwoga & Sanga, 2007), and its termination is bound to adversely affect the success of the e-Schools.

In some of the e-Schools, the printers that were in use were products of Lexmark. While the printers were in good working order, they had run out of toner which the schools could not replenish because there is no dealer of Lexmark printers in Kenya. According to the e-School principals, attempts to purchase stock from neighbouring countries failed as the supply for the printer model Lexmark X422 was hardly available, even in countries such as South Africa with distributors of Lexmark printers. Consequently, the e-School users did not attain hands on experience with computer printing.

Despite the challenges of infrastructure, the e-School users were satisfied with the quality of the installed infrastructure. The satisfaction level was relatively lower in Maranda High School and Menengai Mixed High School. These two schools had a very high student to computer ratio. In Maranda, it had taken a very long time for a second computer laboratory to be built and fitted despite a population of over 1,300 students in that school. It later became apparent that in these two schools, access to computers was restricted to students registered for the ICT course only. This was a real source of dissatisfaction amongst the students. Overall, the teachers and students in the e-School agreed that the quality of infrastructure was good. Statistically, the chi-square values for all the variables were below 0.05, which supported the rejection of the null hypotheses. Consequently, it was concluded that the quality of the installed ICT infrastructure in the e-Schools contributes towards their success.

7.2.1.2 Hypothesis 2: The quality of information content and communication contributes to the level of success of the e-School

The study established that while the content quality of the e-Schools was good, communication effectiveness was not of a high quality. The e-School users could efficiently retrieve and read materials through the e-School and the content retrieved from the e-School LAN was relevant to the curriculum. Similar studies have also underscored the importance of the quality of electronic content. In an evaluation of ICT as a tool for enhancing teaching and learning in the United Kingdom, Rogers and Finlayson (2004:301) established that 70% of the teachers felt that the content retrieved from the internet had the potential to clarify subject matter and promote thinking. However, even while the internet contains vast reading materials covering virtually all subject areas, new users of the system can easily suffer from information overload. Thus if useful sites were selected and filtered for secondary school students, the resources would be more useful to their learning. Lack of the right content actually delimits the success of self-directed learning.

The format quality of the content encouraged the use of the e-School. Communication was good for the students who were at the schools when the consortia installed and maintained the system between 2005 and 2009. After 2009 when the consortia members withdrew their services, allegedly because their contracts were not renewed, communication became a challenge, particularly with the disconnection of the VSATs through which the e-Schools could access internet. The e-Schools' management subsequently restricted access to the internet on account of cost. The schools relied on dial-up connections through the servers. Dial-up connections are charged based on the download bandwidth consumed and are therefore costly to maintain. In a similar study on the pedagogical integration of ICT in Uganda, Ndidde, Lubega, Babikwa and Baguma (2009) identified cost as the main obstacle to internet connectivity in schools. With limited internet access, the exchange of ideas between peers in different e-Schools is curtailed. For the same reason, students could not make many new friends through the network of e-Schools like they used to when internet access was unrestricted.

Despite the challenges cited with respect to communication and content, the null hypothesis was rejected on the grounds that the chi-square statistics revealed that all the observed frequencies of the variables were above the minimum expected frequencies and that all the test statistics had a p value of 0.000, which is less than the set value of 0.05 set for this study. This therefore means that information content and communication quality is positively contributing to e-School success.

7.2.1.3 Hypothesis 3: High service quality offered by the technical personnel contributes to the success of the e-School

In order to maintain the usability of the installed infrastructure, deliberate efforts have to be made to maintain the system. Every e-School had at least one technical person to maintain the system and provide user support. The quality of the services offered by the technical staff was adequate. The technical personnel's knowledge of the e-School exceeded the expectations of the users (teachers and students). However, teachers' and students' expectations were not met in the attention provided to them and the promptness of the technical staff's response to teachers' and students' requests for user support.

The knowledge gap between most of the users and the technical staff was certainly wide. Most of the users were encountering the e-School system for the first time while the technical personnel were professional users of ICT. However the number of technical staff was small, which posed a challenge to providing individual attention to the e-School users. In service sectors such as banks, it has been established that service quality is improved with more customer-care personnel (Newman, 2001). It is therefore understandable that the attention provided to students and teachers and the promptness of the response was below the expectation yet had a favourable rating of 65% in this study.

Overall, the significance levels of the chi-square values for all the variables except the knowledge gap between users and technical personnel were 0.000, which is less than the set p value of 0.05. The p value for the knowledge gap between users and technical staff was 0.115, which is not significant and therefore supports the assertion that the technical personnel were knowledgeable about the e-School system. Even though there was a gap between user's expectations and actual service delivery in respect to timeous service and the approach to users' issues, users expressed satisfaction with the service quality. This combination supported the rejection of the null hypothesis. The overall results confirm that the service quality of technical personnel is positively contributing to e-School success.

7.2.2 Objective 2: Determine the effectiveness of the training imparted on teachers and students to enable them to constructively engage with the installed ICT infrastructure in teaching and learning

In working towards this objective, the study tested the following set of hypotheses ($H4_1$ and $H4_0$):

7.2.2.1 $H4_1$: Effective training method and approach contributes to the success of the e-School system and $H\ 4_0$: Effective training method and approach does not contribute to the success of the e-School system

The e-School users received training on the use of the e-School infrastructure. A few teachers (ICT teachers) were taken to training seminars by the Kenya Chapter of the e-Africa Commission. It was envisaged that these ICT teachers, also known as ICT champions or coordinators, would in turn train other teachers in their schools and also induct students in the use of the e-School.

Training was conducted using a variety of methods, including lectures and demonstrations, with the latter taking center stage. Wide use of the demonstration method supports the finding that most trainees attained hands-on experience. Demonstration as a behavior modeling technique is known to have a greater impact on computer self-efficacy (Chou, 2001). Hands-on experience is particularly important as the e-School users are expected to be independent. E-learners and therefore e-School users should be accustomed to independence. This is necessary to enable them to operate in environments where there is limited user support. Much work has been done towards this in the form of personalized services (Chen, Lee & Chen, 2005). Reliance on user support may result in disruptive frustration when such support is not forthcoming. It was, however, revealed that many users were looking forward to additional training. This is very revealing, particularly in the case of teachers. The training of both teachers and students was done to equip them with technological skills. The training imparted on teachers did not take into consideration the need to equip teachers with pedagogical skills that are suitable for the integration of ICT in teaching and learning. It is therefore not surprising that students disagreed with the suggestion that they received coaching from their teachers through the e-School.

Training was conducted over a short period of time. Given the large number of new students registered every year and the few workstations available, the period of training had to be shortened to just one day for a group of students per year. This was certainly inadequate, particularly for students who were interacting with ICT hardware and software for the first time. Within the short period the training was given, valuable time was sometimes lost to interruptions to the power supply and trainers' need to slow down to accommodate the most disadvantaged students. In most settings, trainees shared computers which further limited the time for hands-on experience. Nevertheless, trainees obtained basic grounding in the use of the e-School.

According to students and teachers, the trainers had reasonable knowledge of ICT operation. However, the trainers did not keep up with evolving information technologies. This became evident from the insights of the e-School users who had prior training outside the e-Schools. This group of trainees occasionally faulted the trainers and could identify the limitations in their experiences with the trainers. A good proportion of the e-School users who had been trained said that they required additional training. However, the group of users who required additional training was statistically different (chi-square = 42.8; p = 0.000) from the group that had obtained hands-on experience during training. It is therefore evident that those who seek additional training do so because they did not benefit from the initial training for different reasons. This supports the rejection of the null hypothesis and reinforces the proposition that training effectiveness contributes towards e-School success.

7.2.3 Objective 3: Establishing the extent to which e-School infrastructure is being used to enhance teaching and learning and provide health information

In working towards the achievement of this objective, the study was guided by the following set of hypotheses:

7.2.3.1 $H5_1$: High and exploitative usage of the e-School system contributes towards the success of the e-School system and $H5_0$: High and exploitative usage of the e-School system does not contribute towards the success of the e-School system

The e-School is being used by both teachers and students. The respondents in this study accessed the e-School regularly irrespective of their gender and role as either teacher or student. A key aspect which has encouraged the use of the e-School is that it is easy to use, to the extent that even learners who had never encountered it before but who had obtained hands-on experience with ICTs elsewhere did experience any problems. Despite wide usage, teachers did not incorporate the use of ICT in everyday classroom teaching. This was partly because the infrastructure had not been diffused to classrooms and also because teachers' pedagogical skills in inquiry-based learning were inadequate.

The users relied on the e-School to access materials supporting the curriculum. At the time of writing, users could only access such materials from within the e-School LAN. Materials from other e-Schools and sources outside the LAN could not be accessed due to inadequate internet connectivity. The restricted internet connection had also curtailed collaboration between peers in different e-Schools. Some users accessed material which was irrelevant to the approved curriculum. Most of the users who accessed such material were teachers and they did so through dial-up connections to the internet. Students' access to irrelevant material was restricted by rules and limited access time.

The e-Schools' management had instituted various rules to streamline the system's use. Some rules on the use of the e-School were, however, de-motivating users from innovatively or exploitatively using the e-School system. One of the principal de-motivators in the use of the e-School was the low user to computer ratio. In many cases, users shared workstations, a situation which is incompatible with independent learning activities. This is the prevailing situation in most countries that are integrating ICT in teaching and learning (Enlaces, 2009; Beacham, 2011).

No users could recall ever seeking health information through the e-School. Material on health information was never incorporated into the e-resources within the LANs. It was also evident that teachers had not directed students to seek health information. In the Kenyan education system, there is no subject on health education at secondary school level, making such material irrelevant to the curriculum and therefore less attractive to students. The few e-School teachers who had accessed health information did so by searching the internet through dial-up connections. The chi-square test statistics for all the variables in this dimension had values ranging between 33.86 (access material not relevant to the curriculum) and 264.1 (e-School is easy to use), all recording a significance level of 0.000. The null hypothesis was therefore rejected, confirming that high and exploitative use of the e-School contributes towards e-School success.

7.2.4 Objective 4: Determining the extent to which e-School users (students and teachers) believe the e-Schools prepare students to function in the global economy

In working towards the achievement of this objective, the study tested the following set of hypotheses:

7.2.4.1 $H6_1$: High level of satisfaction of teachers and students with the e-School system (all aspects including system quality, content and communication quality, use, and exploitation and training) contributes to the success of the e-School system and $H6_0$: High level of satisfaction of teachers and students with the e-School system (all aspects including system quality, content and communication quality, use, and exploitation and training) does not contribute to the success of the e-School system.

The e-School users were highly satisfied with most of the variables of user satisfaction. Out of fourteen variables, users' satisfaction was significant with eleven variables (78.57%) with relatively high chi-square values (between 26.17 and 205.01). The most satisfying variable was ease of use of the e-School system - 90.65% of the teachers and students expressed satisfaction, with an accompanying chi-square value of 205.01. Of the eleven variables with a significant level of satisfaction, the lowest ranked was the availability of content that meets users' needs. This variable was only weakly supported by 49.4% of the teachers and students with an accompanying chi-square value of 26.17.

However, there was dissatisfaction with three variables, namely: the ability of the e-School system to facilitate discussion between students, their peers and teachers; sharing what students learn with the learning community; and overall satisfaction with the e-School. This dissatisfaction is also expressed in the numerous complaints raised by users. Issues that users complained about include inadequate infrastructure, poor maintenance of the e-School, unreliable internet, and virus infection. Another complaint was students' dislike for being forced to remove their shoes before entering the computer laboratories. This was allegedly practiced to reduce the dust level in those laboratories.

The dissatisfaction with these variables was strong enough to dissuade the rejection of the null hypothesis. In effect therefore, the study established that the high level of satisfaction of teachers and students with different aspects of the e-School is not contributing to the success of the e-Schools.

7.2.5 Objective 5: Establishing the extent to which the e-School improves the efficiency of school management and the processes of teaching and learning

In working towards the achievement of this objective, the study tested the following set of hypotheses:

7.2.5.1 $H7_1$: Net benefits of IS contribute to the success of the e-School system and $H7_0$: Net benefits of IS do not contribute to the success of the e-School system

The public has a favourable opinion of the e-Schools. Parents of most students in the e-Schools preferred them to other schools. The parents felt that the e-Schools have better facilities and offer good learning environments for students. Teachers, however, did not seem to share the same view. The integration of ICT into teaching and learning is a platform that requires teachers to abandon their traditional methods of teacher-centered instruction, where teachers are the gatekeepers of knowledge and students the passive recipients of knowledge. It also requires teachers to learn new techniques which may be viewed as a burden by some teachers.

The study established that the e-School helps students perform better, to some extent, in their examinations, makes learning and teaching more enjoyable, and encourages independent learning**.** This finding was variously supported by respondents in the sample. Academic performances of the individual students in some of the e-Schools improved as they continued to engage with the e-School and the overall the performance of those schools also improved in national ranking. Performance decline was visible Isiolo Girls High School and Wajir Girls High, The cause of this decline could not be established in this study.

The e-School was found to have some influence in teamwork between students and between students and teachers within and between the e-Schools. Teamwork skill was enhanced more by interaction within an e-School's learn. The between e-Schools effect was very little due to limited internet access. The e-School was also said to encourage independent learning and therefore contributes to the capacity for lifelong learning. Both teachers and students felt that the e-School provides students with the ability to practice lifelong learning. The chi-square statistics, however, revealed that whereas the level of perceptions were significant in all the variables, the chi-square value was lowest for collaboration between teachers and students (chi-square = 53.1) and improvement in teamwork skills (chi-square = 89.2). This resonates with the findings of similar variables under the user satisfaction dimension that these perceptions were only weakly supported (48.1% for collaboration and 45.2% for teamwork skills).

The e-School has facilities for teaching, learning and management. It was established that the e-School infrastructure helps in the efficient use of resources. Thus the deployment of resources in the e-Schools is more efficient than in other schools. In particular, reporting is made more effective. Teachers may prepare accurate student academic reports in a timely manner and school administration has data which is used to generate reports to the centralized government administration.

Numerous other benefits of the e-School were listed by the respondents. The most commonly perceived other benefits were gaining computer literacy, making and connecting with new friends, and improved understanding of the subject content, there is also the opportunity to use the system to identify possible job vacancies.

On the strength of chi-square statistics, the null hypothesis was rejected. This means that the net benefits are contributing towards the success of the e-Schools. The NEPAD e-School was therefore found to be accruing benefits similar to those that have been identified in similar programmes in other countries, including Britain's SCHOLAR (Simpson, Payne & Condie, 2005) and the Malaysian Smart School (Ya'Acob, Nor, & Azman, 2005), among others.

7.3 Conclusion

This section provides a conclusion on the veracity of the empirical testing of the E-School Success Model. This is followed with concluding statements about the success of the pilot e-Schools. The implications of the study on theory and practice are also discussed.

7.3.1 The E-School Success Model

The evaluation of NEPAD's pilot e-Schools in Kenya was underpinned by the E-School Success Model which is an adaptation of DeLone and McLean's (2003) IS Success Model. The E-School Success Model was found to be a valid model for the evaluation of e-Schools. The seven dimensions of the E-School Success Model that were conceptualized through a literature review were validated. Of the seven dimensions, the training effectiveness dimension was a new variable in IS success evaluation. This dimension was supported empirically and its factor loading to e-School success of 0.4419 is above the 0.400 allowed for exploratory instruments in IS (Vandapalli & Mone, 2000). The study therefore successfully re-specified DeLone and McLean's IS Success Model to suit the evaluation of the success of the e-Schools.

7.3.2 Success of NEPAD's pilot e-Schools in Kenya

The seven dimensions of the E-School Success Model were individually tested for their contributions towards the success of NEPAD's e-Schools in Kenya. Statistical tests and document analysis revealed that six dimensions were positively contributing towards the success of the e-Schools. The only dimension whose contribution to e-School success could not be confirmed was the user satisfaction dimension.

In all the e-Schools, necessary basic ICT infrastructure had been installed and was mainly accessible from computer laboratories. Accessing infrastructure from computer laboratories was limiting the use of the facilities. Computer laboratories were open to students only during lesson hours and on condition that students were accompanied by their teacher. This arrangement limits the exploitative use of the e-School which would be optimized by the integration of ICT in everyday classroom teaching and by giving access to learners in their free time to review lessons, receive online coaching from teachers, access supporting e-resources that are relevant to the curricula, and collaborate with peers and teachers in other e-Schools.

The study established that during the period that the e-Schools had internet links through VSATs, the extent of collaboration and communication between peers was acceptable. This had put the pilots on the path to achieving the goals of the NEPAD e-School project. The users found the content and communication quality to be acceptable. In particular, the content available within the LAN and WAN was relevant to the curricula and made learning easy and enjoyable. The exchange of materials between the e-Schools when they had the VSAT connection was active and effective, and downloading additional materials from the internet enabled students to learn better. With the severance of VSAT links, the efficiency in communication and the effectiveness of collaboration drastically diminished. However, the enjoyment of teaching and learning with the integrated ICTs has continued to help students improve their performances in some e-Schools. Four of the schools had maintained improved performances in national examinations between 2005 when the e-School systems were installed and 2010 when data collection was conducted. This positive impact endeared the e-Schools to parents who have shown a willingness to participate in the maintenance of the ICT infrastructure of the e-Schools, as in the case of Chevakali High School. In Chevakali High School, parents bought additional computing facilities which were installed in the classrooms to facilitate the more effective integration of ICT in teaching and learning.

Despite the challenges in the maintenance of e-Schools, the satisfaction level with the e-Schools was generally high. Users of the e-Schools were satisfied with some specific aspects of the e-School and with the e-School as a whole. The complaints that users of the e-Schools voiced function more of an indication of how to improve the success of the e-School. Satisfaction is further heightened by the benefits accrued from the implementation of the e-School. In addition to public approval and the improved academic performance of some of the e-Schools, students as individuals are finding learning more enjoyable. This gives students the impetus to learn beyond the limits of curriculum objectives. The students learn to work in teams and at the same time to cultivate a culture of independent learning. It is therefore envisaged that the contingent of students graduating from e-

Schools will adapt well in the knowledge society, which requires collaborative efforts in innovation and up skilling through lifelong learning.

Therefore, if all the required infrastructure and resources for integrating ICT in teaching and learning in the e-School were installed and made widely accessible with sufficiently trained users, the e-School would certainly provide all the benefits envisaged. As was revealed in the statistical test of user satisfaction's contribution to the success of e-Schools, the main obstacle to e-School success was the sorry state of internet access. Improving internet access and encouraging peer networks between students should significantly increase the potential for e-School success. Providing pedagogical skills aligned to inquiry-based learning and the deployment of an adequate number of skilled teachers would further improve the success of the e-School.

The study therefore achieved its objective of evaluating the success of NEPAD's pilot e-Schools using a re-specified version of DeLone and McLean's (2003) IS Success Model, i.e the E-School Success Model. The model was found to be robust within the assumptions of the current study and facilitated confirmation that NEPAD's pilot e-Schools in Kenya could be highly successful. It is therefore prudent for stakeholders to continue investing in the NEPAD e-School project as they address the gaps and challenges that were identified through the model and study.

7.3.3 Implications on theory

The current study heeded DeLone and McLean's (2003) advice to information system researchers that IS evaluation should use a validated model and instrument to facilitate the comparison of results. This study therefore joins other studies that have followed this advice and re-specified DeLone and McLean's (2003) IS Success Model to evaluate systems' success, including e-commerce systems (Chang, Torkzadeh & Dhillon, 2004; Molla & Licker, 2001), knowledge management systems (Wu & Wang, 2006; Ong & Lai, 2004), and educational course content management systems (Adeyinka, 2009), among others. The study fills the gap in literature by contributing to the conceptualization and validation of the E-School Success Model. The re-specification of DeLone and McLean's (2003) IS Success Model introduced a new dimension, training effectiveness, to the IS evaluation model. The factor loading of training effectiveness to the e-School dimensions was low (0.4419), but falls within the acceptable range for exploratory studies. Such low loading could be attributed to low content validity. There is therefore a need to further improve the instrument for evaluating the training effectiveness dimension.

The study's use of cross sectional analysis could not facilitate corroboration of students' perceptions with reality on the ground. A longitudinal study design could facilitate the evaluation of the performance of students who have completed learning in the e-Schools. This would require tracer studies which often impose constraints on time and financial resources (Swartland, 2008).

7.3.4 Implications on policy

Experimentation with e-Schools has gained momentum since 1999 in many countries the world over. In Africa, the NEPAD e-School was considered to be a grand innovation, but only 17 out of 54 African countries are currently piloting the programme. Furthermore, in the countries that are piloting NEPAD e-Schools, the project has gone on for far too long without the full roll-out of the programme. The cost implications of deploying e-Schools at national level are very high (Enlaces, 2008). However, with the knowledge of its potential established in the current study, governments, particularly the Kenyan government, should consider taking on the challenge and expanding the programme to more schools in phases. This could be achieved by introducing at least one e-School in each county (new description of administrative regions in Kenya) every year as well as inviting the public and private sector to participate in the expansion for more rapid uptake.

Teachers in the e-Schools appear to be less enthusiastic about the programme. The cause of this may be the challenges that they are encountering. For one, deploying the e-School with the current student to teacher ratio is increasing the workload of the teachers. Secondly, applying inquiry-based pedagogy requires teachers to unlearn their existing skills and acquire new skills. Training demands resources, both in terms of time and finances. Teachers may sacrifice time to go for training, but find it difficult to source the funding to train. The government could develop policies that ensure that the desired skills are incorporated in teacher in-service training as in the Chilean case (Kozma, 2008) or teacher education curricula as in the UK. The government should also encourage teachers to attend training by providing the teachers with incentives.

7.4 Recommendations

This section highlights the problems that were identified in the current study and proposes recommendations that could be implemented to bridge the identified gaps. The recommendations are organized under the objectives of the study.

7.4.1 Objective 1: Establishing the ICT infrastructure installed in the NEPAD e-Schools and determining the infrastructure's quality, accessibility and suitability for enhancing teaching and learning

The study revealed that apart from Chevakali High School, five of the e-Schools had computer laboratories as the only access point to ICT for integration in teaching and learning. Whereas this is the prevailing situation in most countries that are implementing e-Schools, it is not ideal for ICT integration in teaching and learning (Czerniewicz & Brown, 2006). There was also a limited number of computers, resulting in a high student to computer ratio that negatively affects other objectives of the e-School, such as inculcating independent learning skills. The e-Schools' VSAT links for internet access had also been disconnected due to non-subscription. As a result, e-Schools were accessing the internet through dial-up connections, through their server and distributing the access within the LAN. This results in slow internet services which are also costly and therefore unsustainable. The limitations on connectivity are slowing down the success of the e-Schools. Lastly, the service quality that was experienced by the users was not the quality that they expected. The technical personnel were not pleasant to users and did not act on users' support requests in a timely manner.

7.4.1.1 Recommendations on infrastructure quality

i. There is a need to improve the quality, accessibility and suitability of the installed ICT infrastructure for enhancing teaching and learning. This could be achieved by installing additional workstations in classrooms for use by students during and after class. At the very least, students and teachers require a few computers and projection equipment in the classroom, which is what is expected in the United Kingdom (Beacham, 2011). Yet presentation facilities alone are not sufficient. Installing additional computers in the classrooms would enable the students to extend e-learning activities for both classroom sessions and independent learning. This aspect of ICT diffusion has been missed completely in the majority of ICT integration policies in countries implementing e-Schools despite its critical contribution to the success of e-Schools (Tondeur, vn Keer, van Braak & Valcke, 2008). To save on space, infrastructure diffusion which blends the use of desktops and laptops could be considered. Some classrooms which have more floor space may use this to install desktops. As in the UK, classrooms with a smaller floor area could use mobile laptops (Beacham, 2011). However, this would require additional personnel to control the lending and use of the laptops.

ii. Pooling internet access demand and purchasing bandwidth in a bundle is one way of reducing the cost of internet access. This model has been used by tertiary institutions in Kenya where KENET pools access demands, buys bandwidth from Jambonet at half the commercial price, and re-distributes the bandwidth to subscribing tertiary institutions (KENET, 2007). The e-Africa commission envisaged a similar model when it arranged for NEPAD e-Schools to access the internet through RASCOM (NEPAD, 2005). While this arrangement stalled when e-Schools were handed over to the Ministry of Education following the expiry of the contracts of ICT consortia, the Ministry could consider pooling bandwidth demand by e-Schools and purchasing this from RASCOM. This would also require budgetary allocation but at a cheaper rate than if the e-Schools bought internet access individually. The contribution of internet availability to the e-Schools is paramount to their success as it is through this connection that students create their network communities and access additional content (Sife, Lwoga & Sanga, 2007).

iii. In the service sector, of which education is a part, the number of customer-care personnel has been shown to have an effect on the quality of services (Newman, 2001). One reason behind why the technical personnel could not promptly act on the e-School users' support requests was that there was only one technician available in the computer laboratory. For a class of 40 to 50 students, many of whom are disadvantaged, one person may not be enough to effectively provide user support. It is therefore necessary for the ratio of students to technical personnel to be reduced. Technical personnel should be given customer care training so that they may improve the quality of the service that they provide to e-School users. In their training, attention should be given to the capacity of technology to deliver service. Service encounters have been revolutionized using technology, and therefore training in the infusion of ICT use in service delivery should go a long way in improving service quality (Bitner, Brown & Meuter, 2000).

7.4.2 Objective 2: Determine the effectiveness of the training imparted on teachers and students to enable them to constructively engage with the installed ICT infrastructure in teaching and learning

Most of the teachers and students complained that the training period was inadequate. In some cases, the training period was very short, lasting only one day. This was partly because of the large population of new students enrolling in e-Schools at the beginning of each year, and partly because the schools' timetables did not facilitate induction in the use of ICT for teaching and learning. ICT skills development is not explicitly part of the curriculum in secondary schools (with the exception of students studying computers as a subject). Teachers and students expressed the need for additional training. In the case of students, the additional training was required for technical ICT skills. Teachers required both technical and pedagogical training. Teachers training in the use of e-School infrastructure did not incorporate pedagogical skills for the integration of ICT in teaching and learning. This was one of the reasons behind teachers' failure to integrate ICT in everyday classroom teaching.

7.4.2.1 Recommendations on training effectiveness

iv. Training effectiveness is a starting point for influencing e-School users' attitudes in support of ICT integration in teaching and learning (Galanouli, Murphy & Gardner, 2004). Studies show that attitude formation is a function of the number of hours of interaction with the ICT (Beas & Salanova, 2006). The decision of NEPAD's e-Africa Commission to ensure that teachers and students were trained is a proper one. The training, however, must be seen to be effective for it to serve the role of moulding ICT users. One of the main reasons the training is not as effective as it should be is the short time allocated to training. It is necessary to increase the time period allocated to training to provide trainees with more opportunities to practice with ICT and attain the reinforcement that one gains from learning with more hands-on experience. To avoid interference with the main school timetable, part of this training could be done in the evening or during the weekend. Students showed a lot of interest in learning how to use technologies and it may be possible for them to sacrifice free time to engage in additional training.

v. The integration of ICT in teaching and learning is a new intervention in improving access to education and the school environment. The majority of teachers completed their teacher training without being introduced to pedagogies relevant to ICT integration in teaching. This is not unique to Kenya. European countries are in a similar situation. To bridge the gap, European countries are using part-time teachers who completed their training in recent years when ICT integration had been incorporated in teacher education (Boelens, 2010:45). These contract teachers are tasked with teaching students to use ICTs in their learning. But this is not adequate. Teachers' positive experience with teaching with computers and their comfort with computers contributes towards the success of ICT integration in teaching and learning (Mueller, Wood, Willoghby, Ross & Specht, 2008). These are very good reasons for teachers to receive effective training in both ICT technical skills and pedagogy that is suitable for ICT integration in teaching (Hayes, 2007). The Ministry of Education could consider incorporating ICT use in education in teacher education curricula, as has been implemented in other countries such as the UK (Department for Education and Skills, 2003). In addition, for teachers already in employment, the in-service training model implemented in Chile could be incorporated (Sanchez & Salinas, 2008). Teachers could also be provided with motivation to seek relevant training on their own. Some training could be computer-based (e-learning) but with content vetted by the relevant authorities, such as the Kenya Institute of Education (KIE). This would be close to the arrangement in Chile where certain regional universities are charged with overseeing the implementation of Enlaces and the training of teachers on ICT integration pedagogies (Kozma, 2008).

7.4.3 Objective 3: Establishing the extent to which e-School infrastructure is being used to enhance teaching and learning and provide health information

The study revealed that teachers and students were using the ICT infrastructure of the e-School. The frequency of use was, however, limited by virtue of the insufficient diffusion of infrastructure. This was mainly caused by limited funding. It was also revealed that teachers and students were at times using the ICT infrastructure of the e-School to access material that was not relevant to the curriculum. The uses of the infrastructure were also not extensive and innovative.

7.4.3.1 Recommendations on the use of e-School infrastructure

vi. To help improve a new system, systematic innovation is required. This has been evident in the evolution of Open Source software (Hippel, 2002:3). Innovation, particularly when underpinned by collaborative efforts, accelerates the drive towards the improvement of a new system. The e-School requires the efforts of skilled stakeholders to improve the approaches to its use. This is similar to the exploration by teachers in the use of whiteboards in the United Kingdom (Hennessy, Deaney, Ruthven & Winterbottom, 2007).In their study Hennessy, Deaney, Ruthven & Winterbottom (2007) established that teachers in different schools make trails with different ways of using whiteboards and share these with their colleagues who further experiment and refine the innovations. Use of e-School infrastructure should encourage experimentation on the part of students and teachers to come up with new ways of doing things. When such innovative ways of doing things are properly recorded, they can be shared through various platforms with the world, and may lead to validation and subsequent adoption. In essence therefore, restrictions on the use of infrastructure should be limited only to ensure the safety of the system and to block destructive material.

7.4.4 Objective 4: Determining the extent to which e-School users (students and teachers) believe the e-Schools prepare students to function in the global economy

Pursuant to the assessment of this objective, the study sought to determine the contribution of user satisfaction to the success of the e-School. The results were mixed, with 21% of the variables failing to support the rejection of the assertion that high user satisfaction does not contribute towards the success of the e-School. The variables with insignificant chi-square values were: the ability of e-School to facilitate discussion between students, their peers and teachers; sharing what students learn with the learning community; and overall satisfaction with the e-School. The two variables that registered dissatisfaction relate to collaboration and communication. These two components carry a lot of weight in the success of the e-School. The last variable is a summary evaluation that considers all the dimensions of the e-School, with the exception of the net benefit dimension. User satisfaction is therefore a very informative dimension of the e-School, and its non contribution to the success of the e-School suggests that a lot more must be done to improve the potential of e-School success.

7.4.4.1 Recommendations on user satisfaction

vii. More efforts should be made to improve e-School infrastructure aspects that facilitate collaboration and communication among peers and between students and teachers. While individuals may learn to use the content within the LAN in an e-School, sharing knowledge with the greater learning community can expose students and teachers to vast knowledge resources and excite them into action (Haddad & Draxler, 2002). The sharing of knowledge in a network of communities is widely applied. It helps to reduce the costs associated with meetings and communication and it works much faster. For example, in an environment with an efficient technology network, instead of a visiting lecturer travelling to a school to give a talk, he or she can achieve this through other technologies such as Skype. In e-Schools, such delivery would be projected to the smart screen. In a similar approach, expert teachers from different e-Schools could co-teach with their colleagues in synchronous mode.

7.4.5 Objective 5: Establishing the extent to which the e-School improves the efficiency of school management and the processes of teaching and learning

The e-Schools' performance analysis revealed that of the six e-Schools, four had experienced overall performance improvement and improvement in languages (English and Kiswahili). However, two e-Schools experienced a steep decline in performance. According to Eng (2005:648), a review of research on ICT integration in teaching and learning has confirmed the small positive impact on students' performance and a few instances of negative impact. It is also important to observe that in the evaluation of e-Schools' net benefits, teachers and students identified some increased collaboration and therefore teamwork with their peers. The support for this benefit was slightly below 50%.

7.4.5.1 Recommendations on enhancing net benefits

viii. Improvement in school performance is a contribution of several factors including distributed leadership (Harris, 2004), quality assurance of students' performance (Cuttance, 2005), and teachers' professional development (Muijs & Harris, 2006) among other factors. Schools may have similar resources but the management of the utilization of these resources determines the outcome in school performance. Deliberate efforts should be made to improve teachers' professional growth and motivate the teachers to appreciate the use of the e-School. Teachers' acceptance of the e-School concept is fundamental to its success. Countries such as Malaysia have found that teachers may not be willing to support the Smart School project because they are not sure of the support that the school administration will provide (Ah-Choo, 2008). Teachers often seek support in professional development to improve skills (Neyland, 2011) and to put aside time for research, training and lesson preparation (Zakopoulos, 2005). In the past, teachers have recommended a review of curricula to make it less examination-focused so that the teaching objectives shift from passing examinations to developing innovation in teaching. In the United Kingdom, studies show that teachers are reluctant to apply pedagogies appropriate for ICT integration in teaching and learning because they are not aligned to passing examinations and are not suitable for faster completion of the curricula (Hennessy, Ruthven & Brindley, 2005). There is a need to improve teachers' professional skills, train them in new pedagogies, and review the objectives and scope of curricula to ensure that inquiry-based teaching pedagogies fit in the curricula.

7.5 Further research

In performing factor analysis, it was evident in the scree plot that the elbow lay between the 5^{th} and the 9^{th} dimension. This study estimated the number of dimensions to be seven as informed by conceptualization. Future studies should investigate the possibility of the existence of more than seven dimensions in the E-school Success Model and articulate these.

The public has a favourable opinion of the e-Schools. At Chevakali High School, this favourable view may account for parents' contribution to the expansion of e-School infrastructure and therefore its improvement. Future studies should consider the impact of net-benefits of the e-School on the quality of its infrastructure. This would help rule out the possibility that the action of the parents of students in Chavakali was an isolated case. Consequently, the direction of hypothesis Ha in Figure 2.4, which could not be established here but which appears to exist, may be resolved.

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Appendix 1

Observation Schedule

(1) Observation schedule (this will be completed one for each school)
Name of School____

1. What is the grade of roads leading to the school____
2. How many computer laboratories are in each school?___________________________
3. How many computers are installed? ____
4. Are some computers installed in classroom? __________________________________
5. What network configuration was used in the LAN? ____________________________
6. Are printers connected in the network? ______________________________________
7. Have learners rights to printing? ____
8. Which printer make are installed? _____________________________________
9. How do networks access internet? ____
10. What software are installed in the computers? ________________________________
11. Is there a specialized software installed for the administration to manage student data and record? ____
12. Are community members allowed access to a computer? __________________
13. Do community members access health points in the e-school system? ____

Appendix 2

Interview Schedule

Structured Interview for Head of E-school System in the School

Name of School ____

1. Who maintains the computer networks?____
   ____
2. Who supplies consumable products such as tonor?____
   ____
3. Which organization installed e-school system in your school?____
   ____
4. How many teachers have been trained in the use of e-school system?____
   ____
5. Were teachers trained on how to use computers or were they trained on pedagogical approaches to integration of ICT in teaching and learning?____
   ____
6. How is the training of students on the use of e-school organized and at what form level are the training conducted?____
   ____
7. What issues remain unresolved in the running of e-school system?____
   ____
8. What improvements would suggest should be made in the implementation of NEPAD e-school programme?____
   ____
9. In your view, are the objectives of NEPAD e-school programmes of making students IT literate, making students lifelong learners, informing students of health matters, and making students team players being achieved? PLEASE UNDERLINE THE OBJECTIVES YOU BELIEVE ARE BEING ACHIEVED AND PROVIDE SOME EXPLANATION____
   ____
   ____

What would increase the success of NEPAD e-school programme?

____

____

Appendix 3

Questionnaire

EVALUATION OF NEPAD E-SCHOOL DEMONSTRATION PROJECT IN KENYA

Introduction

This study aims at obtaining your opinion of the success of NEPAD e-school system. The study aims at identifying success and non-successful aspects of the NEPAD e-school system. Your participation in this survey will help in informing the NEPAD e-Africa Commission on which areas of the e-school system should be improved. In volunteering information that may assist NEPAD e-Africa improve e-school system, you are contributing in developing a better education system for the future generation.

We greatly appreciate your participation in this survey. Thank you for taking your time to answer the questions that follow.

Your details:

D1 Please indicate the name of your school

(1) Chevakali Boys High School
(2) Isiolo Girls
(3) Maranda High School
(4) Menengai Seondary School
(5) Mumbi Girls
(6) Wajir Girls

D2 What is your gender (sex)?

(1) Female
(2) Male

D3 What is your designation/ occupation?

(1) Student
(2) Teacher

D4 If your answer to D3 is (1) please indicate your class

(1) Form 1 (2) Form 2 (3) Form 3 (4) Form 4

Instructions

Most of the questions which follow in this questionnaire require fixed answer which is the extent to which you either agree or disagree with the statement. The level of agreement or disagreement is labeled from 1 – Strongly Disagree, 2 – Disagree, 3 – Agree, 4 – Strongly Agree. Please circle only one point in the interval for each question.

A few other questions are open ended. They are intended to give you room to express your opinion. For such questions please give a brief narrative answer.

Infrastructure Quality

I1	Buildings housing e-school equipment are suitable for computer laboratories	**1**	**2**	**3**	**4**
I2	E- school computer hardware have good speed	**1**	**2**	**3**	**4**
I3	E-school smart boards give clear projection	**1**	**2**	**3**	**4**
I4	E-school software is user friendly	**1**	**2**	**3**	**4**
I5	E-School window operating system makes it easy for me to navigate the system	**1**	**2**	**3**	**4**
I6	E-school system has reliable power back up	**1**	**2**	**3**	**4**
I7	E-school computer keyboard and screens are suitable for my use	**1**	**2**	**3**	**4**
I8	E-school printers are easy to use	**1**	**2**	**3**	**4**

I6 What aspect(s) e-school infrastructure would you suggest should be urgently improved?

____

____

____

I7 What action would improve the aspect of the system you have suggested?____

____

____

____

I8 In my view, the current level of e-school system infrastructure quality is sufficient to enable students and teachers make use of the system in teaching and learning.

(1) YES (2) NO

I9 Please explain your answer in I8 above____

____

____

____

Information content and communication quality

C1	It is efficient getting complete reading materials through the e-school system.	**1**	**2**	**3**	**4**
C2	The content retrieved from e-school system is specific and relevant to curriculum	**1**	**2**	**3**	**4**
C3	Exchange of ideas with peers through e-mail has been efficient	**1**	**2**	**3**	**4**
C4	The format quality of content in e-school system has encouraged me to use the system.	**1**	**2**	**3**	**4**
C5	It has been possible to get materials from other e-school on time.	**1**	**2**	**3**	**4**
C6	Some teachers in my school participate in developing some content which are posted to e-school system and shared with other e-school schools	**1**	**2**	**3**	**4**
C7	I have established friends through interconnection between my school and other e-schools	**1**	**2**	**3**	**4**

C6 I encounter difficulty accessing Internet through e-school system?

1 Yes 2 No

C7 If yes please describe the difficulties

____

____

____

____

C8 I consider content retrieved (collected) from e-school system to be:

(1) Better than content from textbooks
(2) Have same quality as content from textbooks
(3) Are not as good as content from textbooks

C9 Please explain your answer in C8

above____

____

____

____

____

C10 In my understanding content in e-school system is developed locally and can be updated when new information is discovered

(1) Yes (2) No

IS Technical Personnel Service Quality

Please consider additional information on this paragraph before answering items E1 through to P3. E1, E2, and E1 are service expectation. That is the level of service you would wish to see achieved. On the other hand, P1, P2, and P3 seek your perception on service level as displayed by the technical personnel assigned in e-school laboratories.

E1	IS technical staff will have knowledge of their jobs	**1**	**2**	**3**	**4**
E2	IS technical staff will give users personal attention	**1**	**2**	**3**	**4**
E3	When IS technical staff promise to fix a problem by a certain time they will do so.	**1**	**2**	**3**	**4**
P1	IS technical staff have knowledge of their job	**1**	**2**	**3**	**4**
P2	IS technical staff gave users personal attention	**1**	**2**	**3**	**4**
P3	When is technical staff promised to fixed a problem by a certain time they did so	**1**	**2**	**3**	**4**

Overall Assessment of Technical Personnel

O1	I would rate the quality of service provided by IS technical staff as adequate	**1**	**2**	**3**	**4**
O2	The technical personnel are pleasant to work with	1	2	3	4
O3	The e-school system is always kept in good working order	1	2	3	4

S4 In my view the technical personnel could improve service provision in the following ways:

1)____

____

(2)____

____

(3)____

Training Effectiveness for E-school Use

T1	Trainers for e-school use applied different training methods	**1**	**2**	**3**	**4**
T2	The training approach used was largely Lecture Method	**1**	**2**	**3**	**4**
T3	The training approach used was largely Demonstration Method	**1**	**2**	**3**	**4**
T4	Training for e-school use gave hands-on experience in use of computer system	**1**	**2**	**3**	**4**
T5	Training for e-school use encouraged me to use the e-school system	**1**	**2**	**3**	**4**
T6	I need additional training on e-school use	**1**	**2**	**3**	**4**

T7 In which location (e.g. within the school) was your training on use of e-school system conducted?

____

____

T8 Did your trainer appear to have good knowledge of use of e-school system? Please explain?

____

____

T9 Was the training period adequate for your learning? Please explain

____

____

T11 what improvements would you suggest for the trainers to consider?

____

____

Extent and Exploitative Use of E-school

U1	E-school system is easy to use	**1**	**2**	**3**	**4**
U2	Students and teachers frequently use the e-school system	**1**	**2**	**3**	**4**
U3	Teachers incorporate use of e-school system in classroom teaching	**1**	**2**	**3**	**4**
U4	I use the e-school system to get additional material specific to curriculum	**1**	**2**	**3**	**4**
U5	I use the e-school system to get lessons taught in other e-schools	**1**	**2**	**3**	**4**
U6	I enjoy use of e-school system for learning purposes	**1**	**2**	**3**	**4**
U7	I use e-school system to collaborate with peers in other e-school	**1**	**2**	**3**	**4**
U8	My teacher gives me additional exercise through e-school system	**1**	**2**	**3**	**4**
U9	I use content of e-school system for independent learning	**1**	**2**	**3**	**4**
U10	At times I access content which are not relevant to curriculum from the e-school system	**1**	**2**	**3**	**4**
U11	Some rules imposed by the school hinder exploitative use of e-school system	**1**	**2**	**3**	**4**

U12 In my view the following rules hinder exploitative use of e-school system

(1) ____

____

(2) ____

____

U13 I have no motivation to use e-school system

(1) Yes (2) No

U14 Please explain your answer in U13 above

____

____

____

E-School System User Satisfaction

S1	The e-school system provides content that exactly fits my needs.	**1**	**2**	**3**	**4**
S2	The e-school system provides sufficient content.	**1**	**2**	**3**	**4**
S3	The e-school system is easy to use	**1**	**2**	**3**	**4**
S4	The e-school system makes it easy for me to find the content I need.	**1**	**2**	**3**	**4**
S5	The e-school system is user-friendly	**1**	**2**	**3**	**4**
S6	The e-school system enables me to control my learning progress.	**1**	**2**	**3**	**4**
S7	The e-school system enables me to learn the content I need	**1**	**2**	**3**	**4**
S8	The e-school system provides the personalized learning support.	**1**	**2**	**3**	**4**
S9	The e-school system makes it easy for me to discuss questions with my teachers/peers	**1**	**2**	**3**	**4**
S10	The e-learning system makes it easy for me to share what I learn with the learning community	**1**	**2**	**3**	**4**
S11	As a whole, I am satisfied with the e-school system	**1**	**2**	**3**	**4**
S12	As a whole, the e-school system is success	**1**	**2**	**3**	**4**
S13	As a whole the e-school system health component is informative	**1**	**2**	**3**	**4**
S14	As a whole my use of e-school system is voluntary	**1**	**2**	**3**	**4**

S15 User of e-school system sometimes raise complaints which relate to the following:

(1)____

(2)____

(3)____

Net benefits

B1	My parents prefer e-school over non e-schools	**1**	**2**	**3**	**4**
B2	Infrastructure/Resources in e-schools help students perform better	**1**	**2**	**3**	**4**
B3	Installation of e-schools helps in efficient use of resources	**1**	**2**	**3**	**4**
B4	Teaching and learning in e-school is more enjoyable	**1**	**2**	**3**	**4**
B5	E-school system facilitate collaboration between teachers and students in different schools	**1**	**2**	**3**	**4**
B6	E-school system encouraged me to learn independently	**1**	**2**	**3**	**4**
B7	Users of e-schools are willing offer recommendations of possible improvements.	**1**	**2**	**3**	**4**
B8	My understanding of a lesson normally improves when I review the topic from e-school content	**1**	**2**	**3**	**4**
B9	My teamworking skills has improved since I started using e-school communication system	**1**	**2**	**3**	**4**

B10 I have benefited in the following other ways as a result of using e-school system

(2) ____

(3) ____

(4) ____

Appendix 4

Research Permit

PAGE 2

THIS IS TO CERTIFY THAT:

Prof./Dr./Mr./Mrs./Miss. HESBON OCHIENG NYAGOWA

of (Address) UNIVERSITY OF ZULULAND SOUTH AFRICA

has been permitted to conduct research in SELECTED SCHOOLS Location,

Central, Eastern, Western, District,

N/Eastern, Nyanza, R/Valley Province,s

on the topic EVALUATION OF NEPAD E-SCHOOL DEMONSTRATION PROJECT IN KENYA.

for a period ending 31ST OCTOBER, 20 11

PAGE 3

Research Permit No. NCST/RRI/12/1/SS/871

Date of issue 11/10/2010

Fee received SHS 2,000

Applicant's Signature

Secretary National Council for Science and Technology