Barriers to Effective ICT Integration in Mathematics: Implications for Its Actualisation in Secondary Schools in Kenya

Jackson Khayati Mwelese, Dr. Wanjala M. Martin and Pius Chililia

Masinde Muliro University of Science and Technology
P.O. Box 165 – 40105, MASENO, Kenya
mwelesejackson@gmail.com

Abstract
The purpose of this study was to analyze the barriers to effective ICT integration in mathematics teaching in Kenyan public secondary schools. The study embraced a qualitative case study design. It involved mathematics teachers from selected secondary schools in Vihiga County. Stratified and proportionate sampling were used to select twenty public secondary schools while simple random sampling techniques were used to select twenty teachers who constituted the sample. Data was collected using questionnaires, interviews and classroom observations of the teachers during their peer teaching sessions. Data was analyzed using descriptive and inferential statistical measures. The results showed that many mathematics teachers in Kenya do not integrate ICT in their mathematics instruction. Those who do, only use technology for their convenience and not integration. Among the cited barriers to this integration are: Lack of knowledge about the best ways to go about the ICT integration in lessons and lack of in-depth training opportunities for ICT integration in knowledge acquisition. This paper also reports on similar studies conducted to explore the feasibility of ICT use in mathematics teaching in secondary schools in Kenya. The findings from this study revealed specific features of a professional development scenario that is integral to ICT integration in mathematics teaching in Kenya. These include poor administrative support, lack of appropriate staff training and quality training for teachers and school principals, lack of qualified ICT coordinators who would assist teachers to integrate ICT in the classroom. It is hoped that these findings will provide great insight in ICT integration especially at such a time as now when all school-going children in Kenya are expected to have access to information technology. There is need for commitment from both the government of Kenya and education stakeholders regarding the implementation of the findings.

Keywords: Technology, Professional Development, ICT Integration, Computer competencies, Innovation, Barriers.

Introduction
Due to the transition from agriculture-based economies to technology and industrial economies, mathematics is regarded by most countries as essential and useful. Its usefulness ranges from social, aesthetic, to utility and communication. Mathematics plays a pivotal role in providing a basis for studying other disciplines such as sciences, technology, geography and economics (Mubichakani, 2012). It is acknowledged by the society as the foundation of
scientific and technological development of a Nation (Mbugua, et al, 2012). Mathematics provides a basic relevant skill in studying other subjects without which we may have problems. Within the mathematics curriculum, the general objectives and rationale clearly state that a mathematics course is designed to enable the learners acquire attitudes and knowledge that will be relevant to his/her life after school. It also aims at fostering a positive attitude towards appreciating the usefulness and relevance of mathematics to a modern society (Wanjala, 2005). Great emphasis is placed on the application to real life situations and practical approaches to the teaching and learning of the subject. Mathematics has been pointed out as a subject area that requires practice, if the objectives of teaching the subject are to be achieved. Despite the important role Mathematics plays in the society, there has always been poor performance in national examinations (KNEC reports, 2009 and 2011). This jeopardizes the career aspirations of many students.

The formidable problem currently facing mathematics education in Kenya is the need to improve students’ performance. Many researchers have sought to explore educational approaches that could ultimately better students’ performance in the subject. More often than not, empirical studies have revealed that students learning mathematics by use of computers perform better than those taught by use of conventional method (Chen, 1999; Wanjala, 2005; Mwelese, 2012; Mubichakani, 2012). Their findings have also revealed that computer assisted learning is capable of motivating learners and bridging the gender disparities that are often exhibited in favor of boys. Based on the findings of these studies, computer based learning could therefore be a solution to the appalling status of Mathematics if effectively implemented.

Global investments in information and communication technology (ICT) to improve teaching and learning in schools have been initiated by most governments (Andoh, 2012). In the United States for example, it is estimated that K-12 public schools invested more than $ 7.8 billion in technology equipment between the year 2003 and 2004. By 2006, the ratio of students to computers in public schools in US had reached 3.8 to1 and nearly 10 percent of public schools had access to the internet (National Centre for Educational Statistics (NCES), 2006). In China, multimedia and computer network has been gradually introduced into the K-12 schools since the late 1990s. By 2005, over 9 million computers were installed in K-12 schools and more than 50 000 schools were connected via local network. In Africa, most governments and non-governmental organizations (NGOs) are emphasizing gradual introduction of computers into pedagogy of school curriculum (Mwei, Wando & Too, 2012). The new partnership in African countries for development (NEPAD) in partnership with NEPAD e- Africa Commission has established e-schools project among African countries such as Kenya, Lesotho, Mauritius, Cameroon, Senegal, Mozambique and Rwanda. The major aim of this project is to equip schools with computer equipment and train teachers and students to use computers. The project has so far been achieved in over 25 schools in the above mentioned countries. Over 1 000 teachers and 20 000 students have been trained to use computers for teaching and learning and also help in managing the schools. Its aim is to ultimately connect the entire 600 000 primary and secondary schools in Africa.

The Kenya government has placed considerable emphasis on the importance of information and communication technology (ICT) in its education sector support programmes. This is evidenced by the promulgation of the national ICT strategy for education and training (Farrell, 2007). The Session Paper No. 14 of 2012 captures information and communication
technology under chapter seven. The Government of Kenya appreciates and recognizes that an ICT literate workforce is the foundation on which Kenya can acquire the status of a knowledgeable economy by 2030 (Republic of Kenya, 2012). It states,

“We live in a digital age and internationally it is acknowledged that without both the infrastructure to support it to exist and human resource capacity to make it work then the Kenyan economy will not function effectively or be internationally competitive.” (p. 51).

Education is seen as the natural platform for equipping the nation with ICT skills. According to the Session Paper No. 14 of 2012, ICT is a major vehicle for teaching and learning from the earliest years. It is at a very young age that learners begin to acquire digital skills which they increasingly use to explore and exploit the world of information and to craft that into knowledge (Republic of Kenya, 2012). The successful introduction and use of ICT in education and training institutions is seen to play a major role in disseminating skills to the wider society and this creates positive impact on the economy (Kipsoi, Chang’ach& Sang, 2012). The Ministry of education has also taken steps to support the implementation of the strategy either by direct action or through the various institutions with which it works. This is seen through its commitment to implementing ICT policy in secondary schools. In 2011, the government of Kenya started ICT for schools programme and five schools in every constituency were supplied with computers. In 2013, the government through the ministry of education supplied computers to 2,000 secondary schools to enable them integrate ICT in teaching and learning (The STAR, 22, April 2013). The government has further shown its commitment of ensuring that one of its manifestos’ promises to provide primary school children with free laptops is realized. This implies that the government of Kenya appreciates the role of ICT in education.

Despite the tremendous increase in the availability of computers in schools, they found out that there was modest progress in the teachers’ use of computers in instruction. Boakya and Banini, (2008) measured the teachers’ readiness to use ICT in schools in Cameroon, Ghana, and Mali with an objective of determining whether teachers were involved in the process of integrating ICT in education in these countries. From their findings, 71% of the teachers who were asked had never used the computer in class, while only 10% had used it for classroom activities. This implies that there is limited integration of ICT in instruction owing to existence of barriers and incentives. Without understanding the key factors that affect the use of computers in instruction, technological resources in schools will continue to be underutilized. As reported in previous studies, most of Mathematics teachers have not yet integrated computer technology in instruction. This gives rise to the notion that there could be factors influencing integration of computer technology in Mathematics instruction. It is on this basis that this study investigated the school related barriers hindering integration of computer technology in Mathematics instruction.

Statement of the Problem
Technology has greatly advanced in the last decade in both developed and developing countries. It has greatly changed the way people learn, communicate and do business. Previous empirical studies world over have highlighted the roles of a computer as an instructional tool in the classroom, particularly in enriching the teaching and learning of Mathematics (Mubichakani, 2012; Wanjala, 2005). However, it is surprising that most schools especially in developing nations and Kenya in particular are yet to integrate its use in
the teaching and learning of the subject. Although most governments and non-governmental development partners such as NEPAD have invested colossal amounts of scarce resources in stocking schools with ICT resources, computer integration in Mathematics instruction is still slow and difficult owing to existence of enabling and disabling factors. It is on this basis that the proposed study sought to establish barriers including administrative factors as well as teacher factors that influence the integration of computer technology in mathematics instruction.

The existence of subtle obstacles suggests that school related barriers play a bigger role in influencing the integration of computers in general teaching areas. This paper considers such barriers influencing the integration of information technology into learning. The conclusion is a synopsis of current trends in the use of computers in education and presents future considerations for effecting the implementation.

Research Questions
The study was guided by the following research questions

1. To what extent has computer technology been integrated in mathematics instruction in secondary schools?
2. What is the relationship between infrastructural barriers and integration of computer technology in mathematics instruction in secondary schools?
3. What is the relationship between pedagogical barriers and integration of computer technology in mathematics instruction in secondary schools?
4. What is the relationship between administrative barriers and integration of computer technology in mathematics instruction in secondary schools?

Theoretical Framework for the Study
There are many hindering factors facing teachers in their quest to implement computer technology in instruction. The present study sought information about the school related barriers that affect the integration of computers in mathematics instruction. Issues identified in the literature as school barriers influencing intentions to use information technology provided a conceptual basis for the study. This study was based on Rogers’ theory of diffusion of innovations which seeks to explain how, why and at what rate new technologies spread through the culture of a social system. Rogers (2003) defines diffusion as a process by which an innovation is communicated through certain channels over time among the members of a social system. He defines an innovation as an idea, practice or object perceived as new by an individual or other unit of adoption. Based on Rogers’ definition of an innovation, computer technology as a tool of instruction in mathematics is an innovation whose users are mathematics teachers and students.

According to Rogers (2003) diffusion of an innovation is influenced by four factors; the innovation, communication channels, time and the social system. He identifies 5 intrinsic characteristics of an innovation that influence an individual’s decision to adopt or reject it. These characteristics include; relative advantage, complexity, ability to try and observe. Relative advantage is defined as the adopter’s perceived advantage of an innovation. Relative advantage therefore influences teachers’ beliefs about an instructional approach to be used. Rodgers defines compatibility as “the degree to which an innovation is perceived as consistent with existing values, past experiences, and needs of potential adaptors” (Rodgers,
2003). Up to this point, the perspective considered has been that of the end user of technology who in this case is mathematics teachers and students.

Rogers (2003) also argues that a social system influences the rate at which an innovation spreads through culture. He defines a social system as a set of interrelated units that are engaged in joint problem solving to accomplish a common goal. The study reported in this paper regards a school as a social system and teachers as units within a social system whose common goal is to better learners’ achievement through effective instructional teaching approaches such as computer assisted learning. It is on his argument about a social system that the proposed study sought to establish the availability and adequacy of ICT infrastructure in schools and strategies schools have put in place to prepare learners towards computer use in instruction.

Methodology
The study adopted a descriptive cross-sectional survey design under a mixed research paradigm to collect both qualitative and quantitative data. This research design was preferred over other designs because of its rapid data collection and ability to help understand populations from a part of it (Orodho, 2002). Stratified random sampling technique was used to select samples that were drawn independently and randomly from the stratum of secondary schools in Vihiga County, Kenya. A questionnaire, an interview schedule and an observation check list were used to collect data from the 200 respondents that participated in the study. Data was analyzed using both descriptive and inferential statistics. Descriptive statistics consisted of frequencies and percentages and inferential statistics included one way Analysis of Variance.

Results
(i) Infrastructural barriers:
Kenya is one of the developing countries that lack the necessary resources and appropriate infrastructure for implementing ICT integration in education. The effective use of ICT would require the availability of equipment, supplies of computers and their proper maintenance besides the acquisition of the support accessories. Most rural areas do not have electricity supply and so they cannot even run a computer in the first place. Even in places that have access to electricity, the transmission is not reliable due to the limited supply. Development of ICT infrastructure in Kenya, like other developing countries is dependent on the availability of the resources e.g. computers, printers, scanners, multimedia projectors which are not available in all educational institutions. ICT requires up-to-date software and hardware. Using these resources is a key feature in the diffusion of technology (Gulbahar, 2007) but this is a rare experience in Kenyan educational institutions. High speed internet connectivity is another pre-requisite for the integration of ICT into teaching and learning mathematics. But unfortunately, internet access is very poor and costly in Kenya.

The results indicate that majority of the teachers reported that computers are too few, are only available in the head teacher’s office in most of the schools, and that they are usually not free whenever they want to use them. It was also shown that the available software are inadequate and not adaptable enough for mathematics instruction, though most teachers indicated that the software was not too difficult or complex for use.
(ii) Lack of operational knowledge and skills:
According to Pelgrum (2001), the success of educational innovations depends largely on the skills and knowledge of teachers. Teachers’ lack of knowledge and skills is one of the main hindrances to the use of ICT in education both for the developed and underdeveloped countries. Integrating technology in the curriculum requires knowledge of the subject matter, an understanding of how students learn and a level of technical expertise. Therefore, lack of knowledge regarding the use of ICT and lack of skill on ICT tools and software have also limited the use of ICT tools in teaching and learning situation in Kenya. The study found out that apprehension was a determining factor in teachers’ attitude towards use of computers in instruction. Apprehension is related to the teacher’s complete understanding of computer technology and its use in instruction. The findings reveal that teachers lack knowledge and skills of using computers.

(iii) Pedagogical routine and practice of ICT by teachers:
Teachers’ attitudes have been found to be major predictors of the use of new technologies in instructional settings. The teachers’ beliefs about teaching and learning with ICT are central to integration. Mwelese and Wanjala (2014) indicate that to be successful in computer use and integration, teachers need to engage in conceptual change regarding their beliefs about the nature of learning, the role of the student, and their role as teachers. Hence the successful use of ICT into classroom largely depends on teachers’ attitudes and belief concerning the whole process. In fact, it has been suggested that attitudes towards computers affect teachers’ use of computers in the classroom and the likelihood of them benefiting from training (Kluever, et al, 1994). It is found that less technologically capable teachers who possess positive attitudes towards ICT, require less effort and encouragement to learn the skills necessary for the implementation of ICT in their classroom activities. Therefore, teachers who have positive attitudes towards ICT itself will be positively disposed towards using it in the classroom (Moseley & Higgins, 1999). Moreover, Harrison and Rainer (1992) found that participants with negative computer attitudes were less skilled in computer use and were therefore less likely to accept and adapt to technology than those with positive attitudes. They concluded that changing individuals’ negative attitudes is essential for increasing their computer skills. Therefore, if teachers want to successfully use technology in their classes, they need to possess positive attitudes to the use of technology. Such attitudes are developed when teachers are sufficiently comfortable with technology and are knowledgeable about its use (Afshari et al, 2009).

The findings revealed that a majority of the respondents indicated that they have too much work due to the busy daily workload, that they do not use computers in teaching; that they do not use computers to give students remedial/revision work despite the assertion that computers make presentation of mathematics lessons orderly. However, most of the teachers indicated that computer use/integration in classroom and in the existing/prescribed Mathematics Curriculum is difficult. On whether teachers wouldn’t be bothered to take a computer to class, results indicate that a majority of the teachers agreed. A majority of the teachers indicated that, once they start to work with a computer, they would find it hard to stop.

(iv) Teachers’ Professional Development:
As revealed in the findings, most teachers lack essential computer skills/knowledge/skills about using computer for instruction, schools lack good software programmes for instruction,
most schools lack mathematics rooms/laboratories and most of the rooms are not equipped with computers. As indicated, there is insufficient expertise/guidelines for helping mathematics teachers’ use of computers for instruction. Most of the teachers indicated that they are not sure on whether they can learn computer language, and that there was need for a firm mastery of computers for teaching.

(v) **Perceived Usefulness of Computers in Instruction:**
The findings indicate that computers encourage individualized instruction, make teaching easy and efficient, are important in teaching, and enhance development of problem solving skills. Teachers also indicated that knowing how to work with computers is worthwhile and will improve teaching. The results indicate that few teachers can’t think of any way they will use a computer in their teaching while a majority disagreed on whether they can do just as well some other way anything a computer can be used for. This could be attributed to the teachers’ perception of the ability of the computer to improve the teaching and learning of mathematics.

(vi) **The Time Factor:**
Lack of time was found to be another major barrier to the use of ICT in mathematics instruction. Teachers find that the use of ICT, both for training and teaching, requires significant investment in time. It was found that teachers who begin using computers in their teaching believe, initially, that technologies create more work for them. As reported in this study, accomplished technology-using teachers rated the lack of time as one of the most problematic barriers to technology utilization in schools. It is important to recognize that mastering technology requires time.

(vii) **Teachers Attitudes towards the use of Computers:**
The results indicated that teachers’ attitude affects their intentions to use computers in mathematics instruction. As noted by the respondents in the current study, the way teachers think about computers’ ability to motivate students to learn, make learning enjoyable and stimulating, enhancing instruction and make learning real and interesting encourages its use in instruction.

(viii) **Teachers’ Self Confidence:**
As earlier indicated in the findings, a majority of the respondents asserted to have a low of self-confidence when it comes to working with computers. This could be attributed to the teacher’s feelings about computers as complex tools which can’t be manipulated with ease and that they lack the necessary skills and competence for their use. This perpetuates their lack of confidence in using computers for instruction purposes. The fact that the usability of the computers and other ICT gadgets heavily relies on continuous supply of power makes their integration unreliable and not appropriate with the common power outages. The poor internet access and its high cost discourage its use by many teachers.

(ix) **Attitudes of administrators:**
The study indicates the growing importance of administrators in the success of technology innovations. It is the lack of realization that school administrators control policy making, financial allocation, and program implementation within schools. The actions, interests, and priorities of the building principal have made a significant difference between effective and ineffective implementation of program change. Regarding computer literacy in schools, it
was noted by many that majority of school principals were computer illiterate. Some of them had functional computers in their offices but lacked the knowledge and skills to use them. 47% of the heads of schools interviewed about their use of technology admitted that they had email addresses accounts that were inactive. 38% attributed this predicament to the lack of computers in their schools, not knowing that the same service could be accessed on their smartphones.

(x) Policy Formulation Issues and political barriers:
The results indicate assertions by most teachers that computers do fit in the educational policy of the school but are not accessible for teacher use, and that there are problems in time tabling lessons for using computers. Inadequate administrative and financial support from school administration was also noted by most respondents. More so a majority of the teachers noted insufficient training opportunities, lack of enough space for allocating computers appropriately and that computers are only reserved for computer students in most schools. Sharma (2003) notes that the most notable of the barriers to the use of ICT in education in developing countries seems to be the political will of the people in the corridors of power. The allocation of sufficient funds for the educational sector and ICT does not seem to appeal to our political class. It can be seen from the budgetary allocations in the national assembly, during annual budget estimates that greater allocations go to defense forces unproportionately rather than education. The premier laptop project was unnecessarily politicized and has since become a mirage in priority. Here the case of India and Bangladesh are worth citing. After the death of Mrs. Indira Gandhi in 1984, Mr. Rajiv Gandhi became Prime Minister of India. Since he was very fond of computers and telecommunications, India witnessed a tremendous growth of computerization and tele-networking in his time. As a result, nowadays, most of the urban schools have computers and are well connected to the Web.

(xi) Leadership and Participation:
In the survey, teachers clearly indicated a call for a voice in the decision-making process. Teachers must not be cut out of the decision-making loop; they should be centrally involved in decisions regarding software and the integration of computers into the mathematics curriculum.

(xii) Inadequate funding
ICT integration and internet connectivity requires substantial funding. This is very hard to manage especially in developing countries like Kenya where many people are living below the accepted international poverty line. The ICT supported hardware and software, internet, audio visual aids, teaching aids and other accessories require huge funds. Therefore the lack of funds to obtain the necessary hardware and software is one of the reasons teachers do not use technology in most classrooms.

(xiii) Vision and Plan
In Kenya, many stakeholders; educators, government, and business leaders consider that ICT investment enhances the instructional use of computers and improves teaching and learning. Even so, neither providing computer tools in the classroom nor providing state-of-art technology in itself alone will make any desirable learning changes in education. This barrier mainly falls into two broad categories: (i) Government vision and plan and (ii) School Vision and plan. The Government of Kenya has emphasized the implementation of ICT in education. This is in line with the requirements for Vision 2030; in order to improve the quality of the educational system and also to create an improved teaching and learning environment to
empower and develop the proficiency of teachers and students in the country. Effective implementation of ICT in education is not merely a vision. Rather, it needs a proper plan, policies, execution and monitoring, which is really a major constraint for a country like Kenya.

Concerning School Vision and plan, it is important to note that a vision gives us a place to start, a goal to reach for, as well as a guidepost along the way. As such, many researchers have pointed out that a school’s ICT vision is essential to effective ICT integration. In Kenya most of the educational institutions are far away from implementing ICT into teaching and learning situations. Also, there are few higher educational institutions in major towns that have ICT facilities but do not integrate it effectively due to lack of a proper vision and plan. So, ICT integration is clearly related to actions taken at the school level, such as the development of an ICT plan, ICT support, and ICT training which are absent in most of the educational institutions in the country.

(xiv) Social and Cultural Factors

Over half of the population of Kenya comprise of women and children who are relatively deprived of access to the advantages of technology. The other marginalized groups are the physically challenged group with visual and physical impairments. Women are under-represented in almost every aspect of ICT implementation in Kenya. Sharma (2003) states that one of the most significant social factors influencing the use of ICT in Bangladesh, Malaysia and other developing countries is the low social status of women and hence providing education or the use of ICT to women is not considered important. This resonates well with the Kenyan case. Women are supposed to be primarily the caretakers of family and children. Men disproportionately occupy academic, management and technical roles, which by virtue of the nature of the work provide easier access to the internet and related technology. Even if women have the necessary hardware and software, they may find little time to use them due to being busy with domestic chores. The Commonwealth of Learning, in association with the British Council and the Commonwealth Educational Media Center for Asia (CEMCA) at New Delhi organized a regional expert group meeting in November 1998. This meeting was attended by participants from Pakistan, Bangladesh, Malaysia, Sri Lanka and India and discussed the challenges and opportunities posed by ICT for women in distance education. In Bangladesh, the key barriers to the use of ICT were found to be language and insufficient education and skills that facilitate the effective use of ICT. Bangladesh and Kenya share a lot in common. Seemingly, what challenges one affects the other because of almost the same economic ideologies. In North Eastern Kenya, for example, many women have no access to education because of the harsh climatic conditions, the Somali culture, infrastructure and insecurity. The populace cannot access ICT technology.

(xv) Corruption

The situation in Kenya represents a distinct case where corruption has found a remarkably safe space in which to proliferate, despite the vigilance of control mechanisms and highly celebrated legal frameworks put in place. Corruption is so pervasive that it has evoked widespread condemnation, both inside and outside the country. Consequently, Kenya has been consistently ranked by Transparency International as one of the most venal among the researched countries (Bhuiyan 2011). As a result, corruption can be identified as one of the strong barriers to the implementation of ICT in education. The misuse of government funds which could have been used to develop other sectors like the integration of ICT in education is channeled in other directions. Huge budgets are passed by the National Assembly to buy modern teaching and learning materials for the improvement of the teaching and learning
process, but in the end only minor improvements are achieved, not commensurate to the investment.

(xvi) Inferential result
To find out if there is any statistically significant relationship between administrative factor, pedagogical and administrative factors and integration of computers in mathematics instruction, ANOVA was used to test three null hypotheses at .05 level of significance. The results are as indicated in table 1 below.

<table>
<thead>
<tr>
<th>Table 1: ANOVA Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent Variable</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Integration of computers</td>
</tr>
<tr>
<td>in mathematics instruction</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Independent Variables</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>infrastructural factors</td>
</tr>
<tr>
<td>pedagogical factors</td>
</tr>
<tr>
<td>administrative factors</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>F:</td>
</tr>
<tr>
<td>4.028</td>
</tr>
<tr>
<td>5.754</td>
</tr>
<tr>
<td>6.201</td>
</tr>
<tr>
<td>Sig.</td>
</tr>
<tr>
<td>.004</td>
</tr>
<tr>
<td>.000</td>
</tr>
<tr>
<td>.000</td>
</tr>
<tr>
<td>S</td>
</tr>
<tr>
<td>S</td>
</tr>
<tr>
<td>S</td>
</tr>
</tbody>
</table>

S - Significant
An examination of the F-ratios in Table 1 indicate that the F-ratios are statistically significant because the large F-values (4.028, 5.754 and 6.201) and the small associated significance levels (p< .05) indicate that there is a significant relationship between the variables. There is therefore need to reject the hypotheses in question. This is a clear indication that the infrastructural, pedagogical and administrative factors affect integration of computers in mathematics instruction.

Discussion of Findings
The study established the school related barriers hindering the integration of computers in mathematics instruction in secondary schools. The infrastructural barriers included inadequate resources i.e. technical support and availability of computer hardware and Mathematics software. The pedagogical barriers included dissatisfaction with the status quo, lack of operational knowledge and skills, pedagogical routine and practice of ICT by teachers and the time factor. The administrative barriers reported include unsatisfying rewards and incentives, administrators’ attitude, technical support services, policy formulation, leadership and participation.

Teachers often require technical assistance as well as pedagogical support such as advice on choosing relevant software and integrating it into instruction. Teachers also need recommendations for ways that technology can be used to meet educational objectives, along with ideas on how to organize a classroom to take full advantage of only a few technologies. It is reported that technology support personnel for assisting teachers is limited in most schools. It was discovered that even schools that had technology support person did not provide teachers with adequate computer assistance.

The responses to the survey indicated that issues surrounding computer hardware were the most serious barriers affecting implementation. Regarding hardware, teachers in both highly and less effective schools reported "serious" to "very serious" concern with "too few computers" and "too few printers." Teachers in less effective schools also reported concerns about "computers being too limited".
One factor that is identified by teacher respondents in this study is the availability and access to software that is subject content appropriate. This factor is perceived by teachers as being a serious barrier that has a negative effect on their using ICTs in their classrooms. The study identified software issues that act as barriers to successful implementation of ICTs in education. These include: matching courseware to curriculum, evaluation, quality control acquisition, setting priorities, security, placement and appropriate use.

Dissatisfaction with the status quo suggests that there must be a reason for members of the system to want to implement technology. Teachers, administrators, parents, school boards, and communities must believe that there are aspects of schooling that need to be improved. Technology should not be adopted for its own sake. The study reported that teachers, like other professionals, will use technology once they understand how it can make them more productive and help them do their jobs more professionally. A genuine need must exist; otherwise, teachers and students are left struggling with a technology that has no value to them. As reported in this paper, most teachers lack operational knowledge and skills. To implement the use of any type of educational technology effectively, teachers must feel confident in its operation and their own ability to integrate it into daily classroom practice. The need for training has emerged in the study as an issue of major proportions. The time factor surrounding the implementation process is viewed by teachers as being a major barrier in their use of ICT. Teachers face a number of potential interruptions during the typical hour-long class and that, consequently, the actual time spent in teaching and learning is shortened significantly. As reported in this paper, accomplished technology-using teachers rated the lack of time as one of the most problematic barriers to technology utilization in schools. They have very little official time for planning and preparing for the use of any new innovation. Therefore, school administrators must find creative ways to provide enough time for teachers to become effective technology users.

Teachers’ pedagogical practices and reasoning influence their uses of ICT, and the nature of teacher ICT use impacts on student achievement. Teachers most often use ICT for 'routine tasks' including record keeping, lesson plan development, information presentation, basic information searches on the Internet). The types of usage of ICT correlate with teacher pedagogical philosophies. The evidence shows that when teachers use their knowledge of both the subject and the way pupils understood the subject; their use of ICT has a more direct effect on student achievement. The effect on attainment is greatest when pupils are challenged to think and to question their own understanding, rather than on exposure to new and additional information.

The implementation of an innovation can be encouraged through the use of rewards and incentives. It was noted in the study that extra pay could stimulate computer use where none has previously existed, or might deter computer-using teachers from leaving the teaching profession. It has been noted that teachers are motivated by formal recognition of their technology endeavors and in technology-related staff development, "release time, remuneration, and recognition" as the "three R's" of staff development. Improvement in student learning serves as the greatest motivator.

Educational leadership occurs at many levels and is key to successful innovations. The study indicates the growing importance of administrators in the success of technology innovations. It is the lack of realization that school administrators control policy making, financial
allocation, and program implementation within schools. Thus, administrators must be educated about the use of technology in schools and sold on value of implementing technology in their schools. The actions, interests, and priorities of the building principal have made a significant difference between effective and ineffective implementation of program change.

In the survey, teachers clearly indicated a call for a voice in the decision-making process. Teachers must not be cut out of the decision-making loop; they should be centrally involved in decisions regarding software and the integration of ICT into the curriculum. Currently there exists little theoretical basis for the development of effective technology professional development. Until this foundation is developed, those responsible for professional development will continue to struggle with how to deliver effective technology-based training.

Lack of support by administrators is identified as a significant barrier toward implementation of ICTs in classrooms. Successful implementation of ICTs can only occur if administrators offer teachers support and leadership. It is noted that in addition to administrators developing a philosophy to guide the implementation of computer technology, they can support the technological professional development of teachers by establishing flexible schedules so teachers can practice what they have learned, encouraging and facilitating team teaching and peer coaching, allowing teachers to visit each other's classrooms to observe technology integration, and scheduling regular meetings among teachers using technology to plan and evaluate instruction.

Integration of any information technology, into educational settings requires change. It requires change in the way teachers think about teaching and in their teaching practices. Teacher attitude towards information communication technology is an obvious significant factor in the implementation of ICT in education. Results indicated that while teachers did not feel that their own jobs were threatened by ICT, they still saw them as dehumanizing, isolating, prone to error and possibly as a violation of the right to privacy. As noted in the paper, inappropriate or inadequate professional development is frequently cited as a barrier to the integration of computers into educational settings. Inadequate pre-service teacher training courses and inappropriate in-service workshops do not prepare teachers to integrate computers into their teaching. It does not include enough time for them to become comfortable with the software, nor does it include support to help them troubleshoot during the early implementation stages and the training experience is not tailored to their needs.

More than any other single factor, teachers' beliefs influence what they do in classrooms. Teachers hold beliefs about students, teaching, and technology that are imbedded in the powerful images of what they would want to happen if they had ideal conditions. Teacher training and continued, on-going relevant professional developments are essential if benefits from investments in ICTs are to be maximized. It is noted that teacher training has a significant relationship with the successful implementation of ICT. Teacher training should also not be limited to teachers who teach computer education; there is need to train all teachers on the use of the technology. A shift in the role of a teacher utilizing ICTs to that of a facilitator does not obviate the need for teachers to serve as leaders in the classroom; traditional teacher leadership skills and practices are still important.
Implications
The study reported in this paper highlights the need to recognize that ongoing action would be required to meet the challenges ahead. There is thus need for the Government to give priority to providing teachers with access to ICT through professional development, quality digital content and ICT infrastructure. Consequently, this would ensure a steady rise in the ICT competency of teachers. Pursuant to this, there is need for ensuring that university teacher training courses equip new teachers with required knowledge and skills for computer use.

There is need for the government to support school initiatives by providing policies and protocols that facilitate the uptake and use of ICT in schools. Priority should be given for securing further investment to ensure that there is a recurrent funding for ICT and a critical mass of quality digital content is available to schools. These could enhance providing all schools with access to affordable telecommunications bandwidth of sufficient capacity, reliable infrastructure and technical support.

There is need for effective school planning for use of computers. The successful adoption of computers to improve student learning requires effective leadership and planning. Adequate time must be allowed for teachers to develop new skills, explore their integration into their existing teaching practices and curriculum, and undertake necessary additional lesson planning, if computers are to be used effectively. There is also need to customize or develop education software to meet local education requirements in teaching and learning.

There is also need for providing a legal and regulatory framework that supports rather than inhibits the use of new technologies to enhance learning. This could guarantee providing access to and applying online resources and services that support continuous improvement in curriculum practice, in classroom and distance settings, and in school administration.

These challenges need to be confronted so that Kenyan students are able to reap the educational benefits available through the effective use of computers. It is important that concurrent actions continue to be undertaken in the three priority areas: connectivity, people and content.

Conclusion
The challenges facing teachers in their initiative are vast and complicated and affect them on a personal and professional level. Teachers are expected to develop their technological skills and knowledge and use computers in their classrooms. The potential of computer technology can only be realized if educators at all levels understand the issues facing them, define the role of computer technology in education, and plan for its appropriate use by classroom teachers. As noted in the paper:

- Staff development for use of new technologies tends to be insufficient and misdirected.
- Computer implementation is used for isolated activities and oftentimes unrelated to key instructional concepts.
- The use of the computer is often "one step removed from the classroom teacher."
- Computer technology has not effected change in schools and is used instead to sustain current curricula.
This paper has been directed towards emphasizing the importance of professional development to any program concerned with the integration of the information communication technology more generally, into teaching and learning. The need for professional development to address teachers’ concerns at practical, control and belief levels and a few strategies for doing this are then addressed. Thus it is hoped that this paper has stimulated thinking about the importance and methodology of professional development in any meaningful integration of the information communication technology more generally into teaching and learning.

References


Sharma, V.C (2003). The Political influence in technology use in learning institution. *International Journal of Instructional Media, 10, 143-160*


