Implications for professional development of pre-service teachers for ICT use in mathematics instruction in Kenya

Wanjala Martin M.S[1] and Chemeli Janeth[2]

[1]Department of Science and Mathematics Education, Masinde Muliro University of Science and Technology (MMUST)

[2]Department of Curriculum Instruction and Educational Media, School of Education, Moi University.

ABSTRACT

Mathematics teachers are expected to integrate technology in their teaching to enhance pedagogical practice and student achievement. However, importance has not been placed on preparing teachers to use ICTs in their instruction. This paper reports on a study conducted to explore the feasibility of ICT use in mathematics teaching at the secondary school level. Based on an expanded variation of the Technology Acceptance Model, a survey of student teachers were collected at local universities in Kenya. It explores the factors affecting the integration of Information and Communications Technology (ICT) in instruction. A questionnaire was administered to 110 student-teachers of mathematics seeking to get their attitudes to ICT in learning and teaching and their initial experiences of the application of ICT in mathematics instruction. In-depth interviews with the student-teachers, as well as university lecturers and teachers, revealed a range of issues that reflected how student-teachers perceive integration of ICT's in mathematics instruction. Recommendations are offered for the improvement of the ICT experiences for student-teachers during training and improved ICT infrastructure in schools. The overriding conclusion is that schools must be supported and resourced properly, and pre-service teachers must have effective ICT training.

Introduction

Information and Communications Technology has become an integral and accepted part of everyday life for many people. Technology is increasing in importance in people's lives and it is expected that this trend will continue, to the extent that technological literacy will become a functional requirement for people's work, social, and personal lives. The creative use of Information and Communications Technology (ICT) in education has the capacity to increase the quality of people's lives by enhancing teaching and learning.

Previous researchers have investigated the experiences and perceptions of the pre-service teacher's use of computer technology in their mathematics instructional practices. Clarke (2007) notes that the coping strategies, among other individual characteristics such as attitude toward computers, technology proficiency, computer anxiety, and computer self-efficacy shape the computing experiences of all individuals including pre-service teachers (Ropp, 1999). Computer mathematics software is useful in motivating and engaging students and offer opportunities for teachers to facilitate learning. Computer technology influence the way mathematics is taught and learned, which affects the students' higher level of understanding mathematical concepts, achievement, their mathematical disposition, and the classroom environment (Noss et al, 1990, Wilson & Krapfl, 1994 in Clarke, 2007).

In an investigation on the use of computer technology among pre-service teachers Pier Junor Clarke (2007) found that the pre-service teachers are motivated to use computer technology in instruction, willing to take risks in exploring new ideas, teaching and learning strategies, and new technologies. However, the lack of resources, principal, other faculty and technical support, and environments that are conducive for teaching and learning during teacher preparation are seen to be prohibitive to the appropriate integration of computer technology. He recommended computer technology use; teachers know how to choose computer technology tools that are appropriate, current, interactive and user-friendly in mathematics; teacher's need of professional development in content, technological and pedagogical skills; and motivation to use of computer technology in the classroom. This study was done in the Caribbean country where the use of computer technology in the subject areas had been initiated. The study reported in this paper was done in Kenya where integration of computer technology in subject areas is slow and difficult and despite the economic challenges has made initiatives towards integration of ICTs in education.

Like many other countries in the world, Kenya has developed National ICT Policy (2006). The ICT policy advocates for innovative practices in the implementation of 8.4.4 curriculum (Sessional Paper No 1 of 2005). It sets out the nation's aims, principles and strategies for the delivery of Information and Communications Technology to improve the livelihoods of Kenyans. Ministry of Education (MoE) introduced the National ICT Strategy for Education and Training (Farrell 2007). The ICT policy gives an opportunity for establishment of grass root based infrastructure for knowledge sharing. In order to realize the policy objectives,

Tele:
E-mail address: msibweche@yahoo.com

commitment is made to integrate ICTs in the delivery of the education curricula. Although the ICT syllabus in secondary schools and teachers' colleges provides basic computer knowledge, skills and attitudes on use of computers, the focus is on the computer as the object of study. Due to deficiencies in the implementation strategy, use of ICT in teaching and learning is lacking in secondary schools.

Mathematics is regarded by most people as essential and useful. Its usefulness ranges from social, aesthetic, utility and communication. Despite its usefulness, student's performance in the subject has remained poor for years and hence the need to improve. Mathematics has been pointed as a subject area that requires practice, if the objectives of teaching the subject are to be achieved. Our classrooms are often composed of students from different backgrounds, with different levels of motivation and are also of a wide ability range. This poses challenges to the teacher and calls for a variety of methods and approaches to teaching, which incorporate a variety of resources. Incorporating several different instructional techniques increases the possibility that all students will develop mathematical understanding through at least one method. Perhaps mathematics instruction could benefit from the use of computers. More often than not, empirical studies have revealed that students learning mathematics by use of computer perform better than those taught by use of conventional method (Chen, 1999; Mubichakani, 2012; Wanjala 2005, 2010). 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 use of information and communications technology in schools has made slow progress even though government has been generous in funding through the Kenya Education Sector Support Programme (KESSP). It is therefore important to understand how and when teachers use computer technology in order to devise implementation strategies to encourage them. Earlier research has shown that initial teacher training in Kenya may not offer student-teachers the experiences they need to become competent in integrating information and communication technology (ICT) in their teaching (Farrell 2007; Gakuu C.M. and Kidombo, H.J., 2010, Mureithi and Munyua 2006). In the light of recent policy developments and investment in school resources and pre-service teacher training, there is need for regular surveys of the ICT situation in schools (Kidombo, H.J., 2009). While the university-based part of the course provides students with the theoretical foundation of teaching, teaching practice offer practical experience. Integrating ICT in teaching and learning involves the use of equipment and active involvement of pupils; therefore it is essential that student teachers have the opportunity to practice using computers in their teaching during teaching practice, where guidance and support are normally at hand. However it has been shown that teachers who act as mentors for student teachers in school placements may not have the necessary competence or experience to offer practical support regarding ICT (Williams *et al.*, 2000). The issue of student teachers' ICT uptake in the classroom is of crucial importance, for it has been argued that use of ICT in teaching during school teaching practice will lead to competent and confident in-service use, while lack of it will mean that future teachers will make little use of ICT. Although the responsibility for student-teachers' training lies with both the university and the school, it is clear that the

practical experience of how to integrate ICT in teaching should be developed during the school placement.

Purpose and Objectives

The study sought to explore the feasibility of ICT use in mathematics teaching by pre-service teachers at the secondary school level. Specifically it sought to:

1. Assess the use of ICTs in mathematics instruction by student teachers on teaching practice.
2. Find out the level of usage of ICTs in teaching mathematics in secondary schools.
3. Find out if student teachers are given pedagogic and technical assistance to use computers in mathematics instruction.
4. Establish the student-teacher's perception of barriers to ICT uptake in schools.

Theoretical Framework

The study was based on the Technology Acceptance Model (TAM), introduced by Davis, which is an adaptation of Theory of Reasoned Action (TRA). This model provides an explanation about user acceptance of a technology. TAM suggests that specific behavioral beliefs, perceived ease of use (EOU) and perceived usefulness (U), determine an individual's attitude toward using. Perceived usefulness is the degree to which a person believes that using a technology will increase his or her performance, while perceived ease of use is the degree to which a person believes that using a technology will be free of effort, and perceived usefulness is influenced by perceived ease of use. As postulated in the TAM, usage of technology will be positively influenced by attitude toward using as well as perceived usefulness and computer self-efficacy has a significant effect on perceived ease of use (Venkatesh and Davis's (1996).
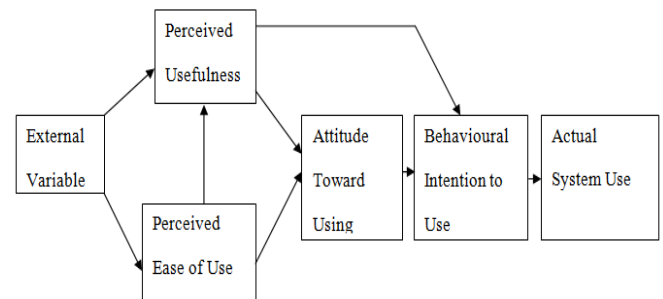

Figure 1: Technology Acceptance Model (TAM)
(Source: Davis et al., 1989)

The TAM model of Information Systems success relies on Fishbein and Ajzen's (1980) Theory of Reasoned Action to assert that two factors perceived usefulness and perceived ease of use are primary determinants of system use. Perceived Usefulness is defined as the user's subjective probability that using a specific technology will increase his or her job performance within an organizational setting (Davis et al., 1989); and Perceived Ease of Use is the user's assessment that the system will be easy to use and require little effort. Straub, Keil and Brenner (1997) suggest that Perceived Usefulness of computers has a positive effect on the adoption of IT (Information Technology). Nelson, and Todd (1992) and Davis (1989) reported that Perceived Usefulness affects both attitudes and actual computer use. While Hu et al. (1999) suggest Perceived Usefulness to be a significant determinant of attitudes and intention. This provides a theoretical basis for the reported study. This provided a basis for the study reported in this paper.

Methodology

The study reported in this paper is eclectic, utilising quantitative and qualitative methodologies and descriptive survey research design. The essence of descriptive survey design was description, recording, analysis, interpretation and making of inferences where appropriate (Shuttleworth, 2008). The researchers preferred its use because of its appropriateness in yielding accurate data. Borg and Gall (2007) make clarification regarding descriptive survey as a method for collection and analysis of data in order to answer questions or test hypotheses concerning the current status of any activity. The target groups were pre-service mathematics teachers. Stratified random sampling technique was used to select samples that were drawn independently and randomly from the stratum of student teachers from Kenyan Universities. Proportionate stratified random sampling technique was used to select 110 respondents from the universities. The survey questionnaire comprising both open and closed questions was designed to elicit information on the general use of computers, their own attitudes to computer use in teaching and learning. The questionnaire was piloted by 20 student teachers and was then revised for the entire cohort.

Data was collected using questionnaires interview and observation schedules. Interviews were conducted by the researcher to get in depth information and understanding of the issues surrounding the implementation of computers in mathematics instruction. Observations were done to collect the necessary data for understanding the factors that hinder or promote the integration of computers in mathematics instruction as perceived by the pre-service mathematics teachers. Data was analyzed using descriptive statistics including frequencies and percentages and inferential statistics the Pearson correlation and multiple regression analysis. In addition, the quantitative analysis was supplemented by qualitative descriptions to provide a fuller picture of the findings particularly in those areas that are not easily amenable to quantification.

Discussion of Findings

The use of ICTs in mathematics instruction by student teachers

The majority of the students (68%) reported they need support in using computer technology in teaching and only 28% were confident that they did not need any support. They also considered that they know more about computer technology than the in-service teachers do (77%). Out of 22 student teachers who feel that they know less about computer compared to their pupils, 14 student teachers reported concern about this. Reasons included the students' belief that pupils knowing more than they do may undermine their authority and their ability to extend pupils' knowledge. With regard to pre-service mathematics teachers' attitudes towards the use of computers and computer use in the teaching of mathematics, the findings revealed that majority of the pre-service teachers agreed with the positive statements in the following proportions: Computers save time and effort (75%), students must use computers in all subject matters(57%), computers would motivate students to do more study (78%), computers are a fast and efficient means of getting information (81%) and finally that computers can enhance students" learning (79%). On the other hand, very few respondents agreed with negative statements as shown in the following proportions; schools would be a better place without computers (25.5%), learning about computers is a waste of time (15%), they would not ever need a computer in

their classroom (8.5%), and finally that computers do more harm than good (21%).

The pre-service mathematics teachers' competencies on computer technology use were categorized into four namely very high competences, high competence, low competence and no competence. The findings showed that the pre-service teachers who had very high competence in computer technology use in a variety of applications were the least (12.73%), followed by those who had high competence (26.26%) then the ones with no competence (29.46%) and finally those categorized as having low competence" carried the highest respondents (30.11%). The highest number of respondents (34%) among those with very high competence was comfortable in one application namely use of the internet in communication. In general majority of the pre-service teachers (59.57%) represented those with low competence plus those with no competence. Therefore just a few of the respondents (12.73%) have the competencies required for application in mathematics instruction.

According to both correlation and regression results, there was a strong relationship between computer use and the teacher's competencies in computer technology use and attitude towards the use of computers in mathematics instruction. This indicated that the competencies in computer use and attitude of pre-service mathematics teachers towards the use of computers influence computer use in the teaching of mathematics.

The level of usage of ICTs in teaching mathematics in secondary schools

The study sought information on the use of computers in mathematics instruction according to student-teachers. Of the student teachers, 41% believe that teachers use computers for preparation only and 28% thought that teachers use computers with the pupils in the classroom. Finally, only 52% of the students believed that the school teachers are aware of the importance of ICT in teaching. The results revealed that only a few of the pre-service teachers (8%) accessed computers at school and yet the same inaccessible computers are to be used in mathematics instruction. Comparatively, responses indicated that the highest number of pre-service teachers (43%) made frequent use of computers mostly in cyber cafés followed by 34% at the university where they are training, then 8% at schools where they taught and lastly the least number of respondents (5%) used computers at home.

When asked about computer application most frequently used either on daily or weekly basis, their opinions were collected and presented as summarized in table 1.

Table 1. Computer Applications Frequently used by Mathematics Teachers.

Computer Application	Number of Respondents	Percentage (%)
Word processing	22	20
Simulation programs	9	8
Graphical tools	11	10
Spreadsheets	13	12
Internet browsing	33	30
Presentation tools	15	14
Teaching courseware	7	6
Total	110	100

Results in Table 1 show higher rating given to internet browsing (30%), followed by Word processing (20%), presentation tools (14%), spreadsheets (12%), graphical visualizing tools (10%), and simulation programmes (8%) and teaching courseware (6%).

The results indicated that student teachers considered themselves to be more conversant with the use of internet, word processing and presentation tools. It might appear that pre-service teachers do not make use of graphical visualizing tools, multimedia and simulation programmes because they consider the applications to be specialized software and require advanced skills from users. This suggests that teachers need training in a wider range of Computer applications for them to make full use of technology in teaching. Programmes like simulation for example, allow teachers to show experiments that would not otherwise be possible, and have great educational potential to enhance teaching (McFarlane and Sakellariou, 2002). This is contrary to the findings of The Gordon University Aberdeen (2004) which revealed that secondary school teacher trainees in Scotland made use of computers as much or more for professional development and communication as in the classroom.

Barriers to ICT uptake in schools according to Student Teachers

The study sought the student teachers' perception of the barriers to the integration of ICTs in mathematics instruction. The findings are as shown in table 2 below.

Table 2. Barriers to use of ICTs in Mathematics Instruction as Perceived by Student Teachers.

Factor	Number of Pre-service Teachers	Percentages (%)
Poor attitude towards ICTs	17	16
Low self confidence in use of ICTs	22	20
Incompetency in ICTs use	32	29
Inaccessibility to ICT infrastructure and technical support	39	35
Totals	110	100

The findings show that student teachers view inaccessibility to ICT infrastructure and technical support (35%) as a major factor hindering teachers from using computers in mathematics instruction. These findings are consistent with those of Ndiku (2003) and Fulton et al (2003) who assert that insufficient number of computers in schools is one of the factors hindering teachers from using computers. The teacher incompetency in computer use came second with (29%). Thirdly, 22 (20%) of the teachers noted the influence of low self confidence in use of ICTs, Lastly, 17 (16%) of the pre-service teachers shared the opinion that poor attitude of teachers and administrators towards computer use was the main hindrance to computer use in mathematics instruction. To find out whether there is a significant relationship between the perceived barriers (attitude, self-confidence, teacher competencies and accessibility to infrastructure), Pearson correlations and multiple regression analysis were performed and the results are as shown in below and in tables 3, 4 and 5 below.

The variables (teacher's attitude and self confidence and ICT use) exhibited a correlation of 0.45252 significant at 0.0718. The variables (teacher competencies and ICT use) had a correlation of 0.441 significant at 0.0842. The variables (accessibility to ICT infrastructure and technical support and use) exhibited a positive correlation (0.341) significant at 0.0648. This implies that there is statistically significant relationship between teacher's competencies, self confidence, accessibility to ICT infrastructure and technical support and use of these tools in mathematics instruction.

Multiple Regressions Analysis

Multiple regressions were used to evaluate the relationship of the dependent variable (ICT use) and a set of independent variables (teacher competencies, self confidence and accessibility to ICT infrastructure and technical support).

Table 3.Regression Model Summary.

R	R Square	Adjusted R Square	Std. Error of the Estimate
.804(a)	.788	.764	.57403

Predictors: (Constant); Teachers' self confidence, competencies in ICTs use, and accessibility to ICT infrastructure and technical support.

According to the results in table 3, an R squared of 0.788 is an indicator of a strong correlation between the variables signifying the factors studied explain 78.8% of the factors influencing the use of ICTs in mathematics instruction.

Table 4. Regression Analysis Results of Relationship between Teachers' Competencies and Use of ICTs.

Variables	Unstandardized Coefficients		Standardized Coefficients	T
ICTs use (Y)	B	Std. Error	Beta	
Constant	32.564	.756		6.032
Teachers competencies in ICTs	2.658	.123	.314	-3.890

A Dependent Variable: Use of ICTs

Regression results in the table 4 show that teachers' competencies in ICT use had a regression coefficient of 2.658. This shows a strong relationship between competencies of teachers and ICT use. This implies that a change in computer competencies of mathematics teachers significantly impact on Computer use.

According to regression results in table 5, teachers' attitude and self confidence in the use of computers had a regression coefficient of 2.531. This shows a strong relationship between computer use and the teacher's attitude and self-confidence. This implies that a change teachers' self confidence in use of ICTs significantly impacts on the use of these technologies.

The results in table 6 show that computer accessibility had a regression coefficient of 3.584. This shows a strong relationship between accessibility to ICT infrastructure and technical support and use in mathematics instruction as

Correlations

		ICT use	Teacher's self Attitude & Self Confidence	Teacher Competencies	Accessibility
ICT use	Pearson correlation	1			
	Sig. (2-tailed)	.			
Teacher's self Attitude & Self Confidence	Pearson correlation	0.45252	1		
	Sig. (2-tailed)	0.07182	.		
Teacher Competencies	Pearson correlation	0.4416	0.026119	1	
	Sig. (2-tailed)	0.084204	0.0097880	.	
Accessibility to ICT infrastructure and technical support	Pearson correlation	0.3411383	0.1023927	0.3502879	1
	Sig. (2-tailed)	0.06489888	0.002962793	0.0002323	.

perceived by mathematics teachers. This implies that accessibility to ICT infrastructure and technical support significantly influences computer use.

Table 5. Regression Analysis Results of Relationship between Teachers' Attitude and Self Confidence use of ICTs in Instruction.

Variables	Unstandardized Coefficients		Standardized Coefficients	T
ICTs use (Y)	B	Std. Error	Beta	
Constant	32.564	.756		6.032
Teachers Self Confidence in use of ICTs	2.531	.249	2.472	10.151

A Dependent Variable: Use of ICTs

Table 6. Regression Analysis Results on Relationship between Teachers' accessibility to ICT infrastructure and technical support and ICT use in mathematics Instruction.

Variables	Unstandardized Coefficients		Standardized Coefficients	T
ICTs use (Y)	B	Std. Error	Beta	
Constant	32.564	.756		6.032
Accessibility to ICT infrastructure and technical support	3.584	.296	-.162	-.1706

A Dependent Variable: Use of ICTs

The correlation and regression performed indicated strong relationship between attitude, self-confidence, incompetency in ICT use, availability and accessibility to ICT infrastructure and use as perceived by pre-service mathematics teachers. This indicated that pre-service mathematics teachers perceive availability and accessibility to computers as a factor that influences computer use in the teaching of mathematics. These findings agree with those of Baylor and Ritchie (2002) who argue that regardless of the amount of technology and its sophistication, technology will not be used unless the teachers have the skills, knowledge and attitudes necessary to use computers in classroom instruction.

Findings of the Interviews

The interview schedule was designed to gather data on the following main issues:

a) Pedagogic support, e.g. issues around teachers' has support for developing ICT-based lessons.

b) Teachers' willingness to use computers in the classroom, e.g. how the teachers' attitudes towards ICT affected the use of computer-based lessons.

c) Teachers' dependence on students, e.g. how the student teachers become agents of change by supporting teachers to use computers.

d) Resources and time, e.g. issues concerning lack of equipment and time for teachers' training.

Pedagogic support

Respondents from all schools reported a lack of knowledge on the part of the teachers in the schools. The students, when they were competent ICT users themselves, did not seem to mind this. They felt they should take the initiative themselves to use computers without any support from the school. Teachers however, were described as being supportive and encouraging but did not offer practical pedagogic support because of lack of knowledge. Lack of familiarity and experience were noted as some of the factors that influence the teachers. Most of them were slowly overcoming their hesitancy to use computer technology. They were accomplishing this by using the computer for word processing. Some noted that they are comfortable with their knowledge level of computers and are not concerned with having to learn more than they already know about computer technology.

One student suggested that, to make the most of their teaching placements and to compensate for lack of school-based guidance, their initial teacher training course should include sessions offered by teachers who have used ICT in their classroom and can offer students practical advice on how to use ICT in their teaching. Technical support, in general terms, was described as good though, it seemed that students could find technical assistance either through technical staff or the ICT coordinator.

Willingness to use computers in the classroom

Students in general were expected to provide ideas and the expertise in ICT during their teaching placements. Several factors were mentioned as determinants for uptake and use of ICT's in mathematics instruction.

Self Confidence

The analysis showed that confidence in using computers was related to exposure to these technologies, as measured by access, professional development, and computer technology-specific teaching experience. Access was also important in relation to how often teachers use computers with their classes; in fact, this was the only factor linked to frequency of use of the technology.

Knowledge and Skills

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. Teachers lack Knowledge and Skills of using computers. 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.

Educational Value of computers

Dissatisfaction with the status quo suggests that there must be a reason for members of the system to want to implement technology. 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. The educational value of computers was found to be a key factor in teacher's intention to use computers in instruction.

Perceived Usefulness on Intention to Computer Technology Use

The results of this study found that teachers' perceived usefulness was significant and strong in determining intention to computer technology use. This can be explained by the fact that teachers find computer technology useful in improving their instructional performance, and motivating their intention to use computer technology in the future.

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 with release time, remuneration, and recognition as incentives. Improvement in student learning serves as the greatest motivator.

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.

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.

Teacher Attitudes

Results indicated that while teachers did not feel that their own jobs were threatened by the computer, they still saw them as dehumanizing, isolating, prone to error and possibly as a violation of the right to privacy. Teacher attitude was identified as a key determining factor for teacher integration of computers in instruction. Most teachers are enthusiastic and passionate about the implementation of computers. The teachers view computer technology as an important and essential part of the instructional process. These teachers are strong advocates for computer use in the teaching and learning of mathematics.

Professional Development

Inappropriate or inadequate professional development is frequently cited as a barrier to the integration of computers in the teaching and learning of mathematics. Inadequate pre-service teacher training courses and inappropriate in-service workshops do not prepare teachers to integrate computers into their teaching.

Pedagogical and Policy formulation Issues

The way computer is used in lessons is influenced by teacher knowledge about their subjects, and how computers can be utilized and related to it. The study has established that outcomes of computer use at the classroom level are shaped by the theoretical framework and beliefs of individual teachers; the range of their pedagogical repertoire; and their sensitivity and responsiveness to the structure, potential and limitations of computer instructional software programs.

Resources and time

Lack of appropriate equipment was another major barrier to the students' use of ICT in their school placements. The quantity and quality of resources varied across schools and there were complaints from the students who pointed out that they were used to having appropriate resources in the university and they found it difficult to adjust when they encountered the school situation. Lack of resources along with the fact that even the existing equipment is usually booked for computer classes make it very difficult for the students to acquire experience in using ICT in their teaching. Limited accessibility to hardware and content appropriate software was identified as a key factor in the implementation of computer use in instruction. The respondents cited inaccessibility to computer hardware and lack of appropriate software tailored according to the mathematics curriculum.

It is obvious that sufficient hardware and software resources must be available for successful computer incorporation. Teachers often require technical assistance as well as pedagogical support such as advice on choosing relevant software and integrating it into instruction. 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.

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 the 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.

Conclusion

The pre-service teachers of mathematics in the Kenyan universities have a positive attitude towards use of computers in mathematics instruction. However, even though the pre-service teachers had positive attitude towards the use of computers, only a few have the competencies required for application in mathematics instruction. The majority of the respondents had varied inadequacies that clearly render them incapable to sufficiently use computers in mathematics instruction. Just a few of the pre-service teachers of mathematics at Kenyan universities accessed computers at school during their teaching practice and yet the same inaccessible computers were to be used in mathematics instruction. The results therefore revealed that majority of the pre-service teachers had no access to computers. Both correlation and regression results indicated strong relationship between computer use and the pre-service teachers' attitudes, competencies in computer use and computer availability and accessibility.

This study has provided evidence that teachers perceive existence of barriers to their use of ICT during school practice as teachers' attitudes, lack of resources and time. Although lack of appropriate equipment was considered an important factor when students were unable to use ICT in their instructional practices, it was also clear that teachers' attitudes play the most crucial role. Time is another considerable barrier to the use of ICT in schools as teachers claim that with the demands placed on them by the curriculum and their other duties, ICT has to take a back seat. Lack of time for teachers mentoring students in school is an issue raised in other studies. Also, there is a great deal of material to be covered during teaching practice by both student-teachers and their mentor teachers and it seems that ICT does not appear to be a high priority item.

The findings confirm what many teachers express privately, i.e. that in-service training in ICT should be a priority. It is clear that a lot of investment and effort has to be put into training teachers in ICT and improving schools' infrastructure, nevertheless there has been no evidence yet for improved school conditions for teachers. The situation of ICT in schools is still patchy and the majority of mathematics teachers do not feel confident to integrate it in their teaching. More drastic and perhaps urgent measures should be taken as teaching practice experiences with ICT are extremely important for the future use of ICT by newly qualified teachers.

The barriers to using ICT in mathematics instruction reported by teachers in this survey are similar to those identified in other studies. As described in the paper,

initiatives are underway to address the need for teacher ICT training and the lack of good equipment. The student teachers in this study reported that (a) they would prefer the university-based part of their course to also prepare them for the situation in relation to equipment and teacher competence which they have to face in schools and that (b) the schools are not in a position to support them in terms of resources or/and pedagogic guidance.

In a nutshell, teacher professional development should be focused on skills with particular applications; integration into existing curricula; curricular changes related to the use of IT including changes in instructional design; changes in teacher role and underpinning educational theories. Ideally, these should be addressed in pre-service teacher training and built on and enhanced in-service. ICTs are swiftly evolving technologies, however, thus teachers need to continuously upgrade their skills and keep abreast of the latest developments and best practices.

Recommendations

From the research findings and the conclusions made, the following recommendations were made:

• There is need for providing teachers with professional learning opportunities to enhance their capacity to fully utilize the opportunities presented by the use of computers and to embed the use of computer in teaching and learning, including the ways in which computer can support assessment practices in schools. University teacher training courses should equip new teachers with required computer knowledge and skills.

• 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 in instruction.

• There is need for developing a framework that could prove useful based on the willingness of the teacher to use ICT in instruction; arrangements for access to computers; envisaged potential of ICT in the mathematics curriculum; nature of professional learning envisaged for pre-service teachers and main strategy of experienced technicians to support teachers.

• Support of school administrators and, in some cases, the surrounding community, for teacher use of computers is seen as critical for effective use of computers.

• Providing policies and protocols that facilitate the uptake and use of computers in schools by prioritizing teacher accessibility to computer resources through professional development, quality digital content and computer infrastructure.

• Content development is a critical area that is too often overlooked. The bulk of existing ICT-based educational material is of little relevance to education in developing countries. There is a need to develop original educational, adapt existing content, and convert print-based content to digital media. These are tasks for which content development specialists such as instructional designers, scriptwriters, audio and video production specialists, programmers, multimedia course authors, and web-developers are needed.

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