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Pedagogical Factors Affecting Integration of Computers in Mathematics Instruction in Secondary Schools in Kenya

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Abstract
The paper reports findings of a study which sought to examine the pedagogical factors that affect the integration of computers in mathematics instruction as perceived by teachers in secondary schools in Kenya. This study was based on the Technology Acceptance Model (TAM). A descriptive survey design was used for this study. Stratified and simple random sampling techniques were used to select a sample of 200 teachers that was drawn independently and randomly from the stratum of secondary schools. Questionnaires, interview and observation schedules were used to collect data from respondents. Data was analyzed using descriptive statistics frequencies and percentages and inferential statistics including one way analysis of variance and regression analysis. The results indicate that mathematics teachers' use of computer technology is significantly related to pedagogical factors such as knowledge and skills in computer, perceived usefulness, access to hardware and software and technical support and pedagogical routine practice. The study provides a basis upon which recommendations on appropriate remedies can be formulated to enhance the integration of computers in mathematics instruction by teachers. This also provides a guideline for the selection of sound instructional approaches in mathematics instruction in secondary schools.
Keywords: ICT pedagogy, instructional software, mathematics classroom

1. Introduction

Mathematics is one of the many subjects in the school curriculum and is regarded by most people as essential and useful. Its usefulness ranges from social, aesthetic, utility and communication. However, in-spite of its importance, performance in mathematics has not been impressive over years (Wando, 2010). Several studies conducted in Kenya have indicated the continued use of the traditional method among secondary school Mathematics teachers (Kiragu 1986; O'Connor, Kanja and Baba (eds), 2000; Too, 1986). Research has shown that the traditional instructional approaches whereby teachers are the ultimate sources of knowledge while students passively receive and record this knowledge in memory are not effective (Bransford et al 2000; Moon 2004; Kozma 2005). Instructional practices need to be improved in mathematics which has been pointed as a subject area that requires practice if the objectives of teaching the subject are to be achieved.

There is need for transforming mathematics lessons into students focused environment with meaningful activities that promote efficient learning of mathematics in our classrooms. Perhaps mathematics education in Kenyan secondary schools could greatly benefit from the use of computer in instruction because of its great potential in teaching those mathematical concepts, which are either difficult to teach by conventional methods of instruction or where students' motivation is low. Computer is perceived to provide students with the needed opportunity to participate actively in the classroom (Hudson, 1999 & Dillon, 2000). In addition to meeting the needs of the students, computers can afford the teacher new ways of teaching a topic. The teacher facilitates learning and is also to ensure that there is success for all students in the mathematics that is being taught.

The increasing availability of electronic calculators and computers at low costs is of greatest significance for the teaching and learning of mathematics in secondary schools. It is highly probable that computers and other new information technologies might influence the efficiency of the instructional delivery of mathematics. International and national studies indicate the importance of integrating computer in mathematics instruction (Kullik J.E, et.al 1993, Turner, G. 1986, Wanjala, M. 2005). Computer technologies contribute to the advancement of school education by providing powerful learning tools and enabling access to new resources across all areas of the curriculum, contributing to the achievement of National Goals, enabling increased access to education for students in remote areas, enabling improvements and efficiencies to be made in the administration of schools and education.

The emphasis on computer based-teaching and learning of mathematics in Kenyan secondary schools becomes more urgent considering the teacher-dominated approach to schooling and teaching in the country. Learning is largely passive and the products of the schools are rated low in creativity, critical thinking and problem solving, apparently, because the schools have failed to develop such skills in them through the integration of digital technologies into the curriculum implementation process. Because of the potency of educational technology to improve education and ameliorate most of the ineffectiveness in the schooling process in Kenya, it becomes necessary to assess the integration of computer technology by mathematics teachers in secondary schools.

The last decade has seen more advancement in technology and computers and curricular materials related to the use of technology are being planted in schools. However, these technological tools are not an integral part of the curriculum. Regardless of many research articles reporting the effectiveness of integrating instructional technologies with mathematics curriculum, teachers are still not consistently using the technologies Research has shown that despite reports on teachers' increasing knowledge of and familiarity with technology and there being infrastructure to support it, many mathematics teachers are still not effectively integrating technology into their teaching (Foley and Ojeda, 2007). Due to the importance of computers in instruction, identifying the possible obstacles to integration of this technology in mathematics instruction would be an important step in improving the quality of teaching and learning. There are many factors facing teachers in their quest to implement computer technology in instruction. The purpose of the research reported in this paper was to identify and examine the pedagogical factors affecting integration of the technology.

2. Purpose and Objectives of the Study

The study sought to investigate the pedagogical factors that affect the integration of computers in mathematics instruction in secondary schools. Specifically it purposed to assess the relationship between teacher's knowledge and skills in computer, perceived usefulness, accessibility to computer hardware, software and technical support and pedagogical routine practices and integration of computers in mathematics instruction.

3. Theoretical Framework

This study was based on the Technology Acceptance Model (TAM), introduced by Davis(1986), 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 as well as perceived usefulness and computer self-efficacy has a significant effect on perceived ease of use (Venkatesh and Davis's (1996).

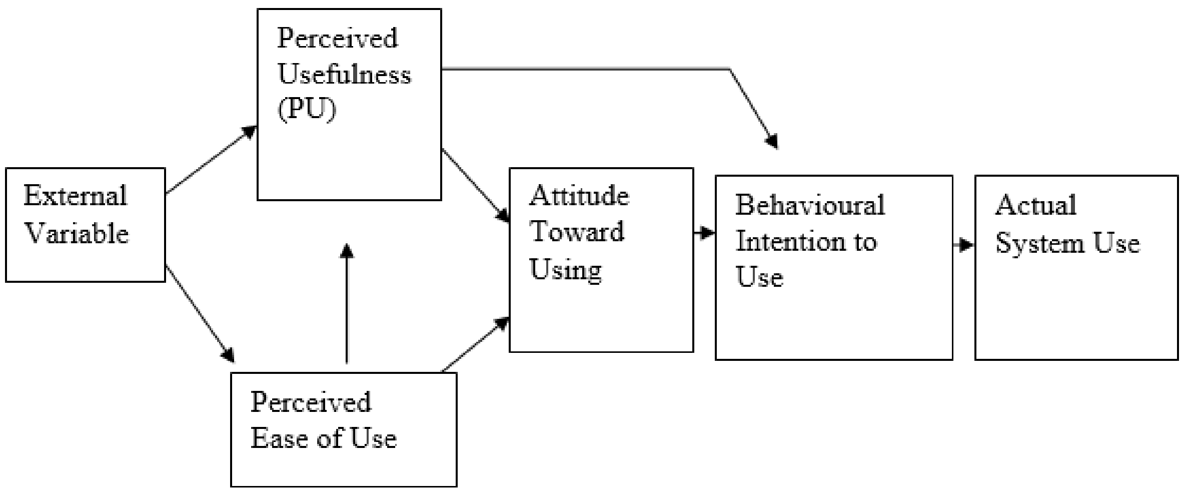

Figure 1: Technology Acceptance Model (TAM) (Source: Davis et al., 1989)

The TAM model 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 (PU) 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). Perceived Ease of Use (PEOU) is the user's assessment that the system will be easy to use and require little effort. Researchers suggest that perceived usefulness of computers has a positive effect on the both attitudes and adoption of technology (Nelson, and Todd, 1992, Davis, 1989, Straub, Keil and Brenner, 1997 and Hu et al., 1999).

4. Methods

The study adopted a descriptive survey design which was chosen because it is appropriate for educational fact-finding as it yields a great deal of information, which is accurate. It also enables a researcher to gather data at a particular point in time and use it to describe the nature of the existing conditions (Borg & Gall, 2007). The study involved 200 mathematics teachers from the 40 sampled schools in Bungoma County, Kenya who were selected using simple and stratified random sampling procedures. The data were collected using questionnaires, interview and observation schedules which were validated and piloted for reliability test using Pearson's Product Moment Correlation coefficient (r) with values 0.75 and 0.8. Data was analyzed using descriptive statistics (frequencies and percentages) and inferential statistics; a one way analysis of variances (ANOVA) and regression analysis.

5. RESULTS

5.1 Teachers' Knowledge and Skills in Computer

The results show that most teachers lack essential computer skills/knowledge about using computers for instruction. Most teachers noted insufficient expertise/guidelines for helping them use of computers for instruction. The schools lack relevant software materials and in most cases mathematics rooms/laboratories are lacking, ill or not equipped with computers. 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. Therefore as indicated in the study, there is need for teachers' professional development in terms of computer applications, computer programming languages, programming skills, and use of computers in instruction with emphasis on proficiency in operation.

5.2 Perceived Usefulness of Computers in Instruction

The findings demonstrate 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.

To find out if there is any statistically significant relationship between teacher's knowledge and skills, perceived usefulness and implementation of computer use in mathematics instruction, the ANOVA was used to test the null hypothesis at .05 alpha level of significance. Results are as shown in Table 1

Table 1: ANOVA Tests Values on Teachers' Knowledge and Skills and Perceived Usefulness and integration of computers in mathematics instruction

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Knowledge and Skills	Between Groups	68.913	4	17.228	1.832	.012
	Within Groups	1833.707	195	9.404		
	Total	1902.620	199			
Perceived Usefulness	Between Groups	352.177	4	88.044	2.140	.007
	Within Groups	8021.418	195	41.135		
	Total	8373.595	199			

Significant at 0.05 level, critical values (2.140>.007 & 1.832>.012)

As indicated in Table 1, the *F* statistic values (1.832 and 2.140) and their associated significance levels ($p < .05$) indicate that this hypothesis as false and hence not supported. Therefore the hypothesis is rejected.

Regression analysis was performed to establish whether the variables teacher's knowledge and skills and perceived usefulness are major factors in the integration of computers in mathematics instruction. The results in Table 2 show that in this model, the R value is .758, which indicates that there is a great deal of variance shared by the teacher's knowledge and skills in computer, perceived usefulness and the implementation of computer use. The R square value is .574, which indicates that 57% of the variance in the dependent variable is explained by the independent variable in the model.

Table 2: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.758(a)	.574	.060	4. 0703

a Predictors: (Constant), Perceived Usefulness, Knowledge and Skills

Table 3: Coefficients (a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	10. 18	.174		5.856	.000
	Knowledge and Skills	200.02	9. 00	.016	.227	.001
	Perceived Usefulness	800.09	4. 00	.128	1.808	.002

a Dependent Variable: Implementation of Computer use

Table 3 provides information about the effects of the variables teacher's knowledge and skills in computer and perceived usefulness on implementation of computer use. The unstandardized coefficients for teacher's professional development and perceived usefulness in this case are 200.02 and 800.09, which indicates that for teacher's knowledge and skills and perceived usefulness, a teacher's predicted computer use will increase by 200.02 and 800.09, respectively. Examining the Beta coefficients, it can be noted that these two variables are more obviously the better predictors of teacher's implementation of computer use. Examining the *t* statistic for the two variables, it can be seen that they are associated with significance values of .001 and .002, indicating that the null hypothesis, that states that this variable's regression coefficient is zero when all other predictor coefficients are fixed to zero, can be rejected. This shows that the teacher's intention to use computers in mathematics instruction can be predicted by teacher's knowledge and skills in computer and their perceived usefulness of the tools in instruction.

5.3 Accessibility to Hardware, Software and Technical Support

The results indicate that computers are 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 is also shown that the available software are inadequate and not adaptable enough for mathematics instruction, though most teachers indicated that soft ware is not too difficult or complex for use. Most teachers lack confidence in using the software and also indicated their inability to trouble - shoot problems with computers. To find out if there is any statistically significant relationship between teacher's accessibility to computer hardware, software and technical support and implementation of computer use in mathematics instruction, ANOVA was used to test the null hypothesis at .05 alpha level of significance. The results are as shown in table 4.

Table 4: Accessibility to Hardware, Software and Technical Support and Computer Use

Accessibility to Hardware, Software and Technical Support	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	410.574	4	102.643	4.028	.004
Within Groups	4969.301	195	25.484		
Total	5379.875	199			

Significant at 0.05 level, critical value 4.028>.004

An examination of results in Table 4 indicates that the F-ratio is statistically significant because the F-value (4.028) far exceeds the critical value (.004) needed to reject the hypothesis in question. This indicates that it is very unlikely that these variables are independent of each other. Therefore it can be concluded that there is a relationship between teacher's accessibility to computer hardware, software and technical support and computer use in mathematics instruction.

Regression analysis results as shown in the output Table 5 below, includes information about the quantity of variance that is explained by the predictor variable. In this model, the value is .039, which indicates that there is minimal variance shared by the independent variable teacher's accessibility to computer and technical support and the dependent variable implementation of computer use. In this case, the squared value of *R* is .001, which indicates that 1% of the variance in the dependent variable is explained by the independent variables in the model.

Table 5: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.039(a)	.001	-.004	.40905

a Predictors: (Constant), Access to Hardware, Software and Technical Support

Table 6: Coefficients (a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.170	.080		14.666	.000
	Access to Hardware, Software and Technical support	.003	.006	.039	.545	.586

a Dependent Variable: Implementation of Computer use

The unstandardized coefficients indicate the increase in the value of the dependent variable for each unit increase in the predictor variable (Table 6). In this case, the unstandardized coefficient is (.003), which indicates that for each teacher's accessibility to computer hardware and software and technical support, predicted computer use in instruction will increase by 0.003. Examining the Beta coefficient we can see that this variable is not a good predictor of computer use in mathematics instruction. Examining the *t* statistic for the variables, it can be seen that they are associated with a high significance value of (.586) indicating that the null hypothesis, that states that this variable's regression coefficient is zero when all other predictor coefficients are fixed to zero, can be accepted. This shows that teachers' accessibility to computer hardware and software and technical support is not a better predictor of teacher's use of computers in mathematics instruction.

5.4 Pedagogical Routine Practice

The results indicate assertion by most teachers that computers do fit in the educational policy of the school, are not accessible for teacher use, and that there are problems related to time tabling lessons for using computers. They also indicated that lack of knowledge of teaching strategies using computers and that there is no lesson plans for using computers in mathematics. Most teachers noted insufficient training opportunities, lack of enough space for allocating computers appropriately and reservation of computers to students taking computer studies. To find out if there is any statistically significant relationship between pedagogical routine practices and integration of computers in mathematics instruction, ANOVA was used to test the null hypothesis at .05 level of significance. The results are shown in Table 7.

Table 7: Pedagogical Routine Practices and integration of computers in instruction

Pedagogical Routine Practice	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1095.040	4	273.760	5.754	.000
Within Groups	9277.680	195	47.578		
Total	10372.720	199			

Significant at 0.05 level, critical value 5.754>.000

The large F static value 5.754 and its small significance levels (.000) P< .05 indicates that it is very unlikely that these variables are independent of each other. Therefore, the hypothesis is rejected. Thus it can be concluded that there is a statistically significant relationship between pedagogical issues and integration of computers in mathematics instruction.

Regression analysis was performed and as shown in Table 8, the value is .743, indicates that there is a great deal of variance shared by the independent variables pedagogical practices and the dependent variable computer use in mathematics instruction. The *R* Square value is .552, which indicates that 55% of the variance in the dependent variable is explained by the independent variables.

Table 8: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.743(a)	.552	.0549	4.0617

a Predictors: (Constant), Pedagogical Routine Practices

Table 9: Coefficients (a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	10.55	.193		11.347	.000
	Pedagogical Routine Practices	800.008	.004	.137	1.769	.008

a Dependent Variable: Implementation of Computer use

The unstandardized coefficients indicate the increase in the value of the dependent variable for each unit increase in the predictor variable (Table 9). The unstandardized coefficient for pedagogical routine practices in this case is **(**800.008**),** which indicates that a teacher's predicted computer use in instruction will increase by **(**800.008**)**. Examining the Beta coefficients for pedagogical routine practice, we can see that this variable is a better predictor of computer use in mathematics instruction.

Examining the *t* statistic for the variables, it can be seen that they are associated with high significances values of (.078) and (.859), indicating that the null hypothesis, that states that this variable's regression coefficient is zero when all other predictor coefficients are fixed to zero, can be rejected. Therefore pedagogical routine practices are better predictors of implementation of computer use in mathematics instruction.

6. Discussion of Findings

There was significant relationship between teacher's accessibility to computer hardware, software and technical support and integration computer in mathematics instruction. It was found that not only does accessibility to computers and technical support serve as strong anchors to user's perception of the usefulness and ease of use of computer technologies but also yield direct influence on usage. Technical support both before and after adoption of the technology has direct influence in computing skill as well. Implicitly, as long as institutions continue to improve general computing skills, and as long as technical backing by experts is available to teachers, usage of computers by will be sustained and enhanced.

Pedagogical routine practices were found to have direct influence on integration of computer technologies in instruction. In the classroom it is the teacher who decides when computer technology is appropriate in the curriculum. Within the classroom environment, when to use and how to use computer technology has to be guided by individual teachers. Teachers' intention to use computer technology is critical to the success of the integration of computer technology in mathematics instruction. Supported by other studies, this study empirically found that teachers' pedagogical practices had direct significant effects on their intentions to integrate computer technology in mathematics instruction. Therefore school administrators should devise implementation strategies to demonstrate how computer technology could improve instructional performance.

The results of this study found that teachers' perceived usefulness was significant and strong in determining intention to computer technology use. This finding is comparable with prior studies in other organizational contexts and technologies (e.g., Mahmood & Swanberg 2001; Legris et al. 2003). 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. The teachers who viewed computer technology as useful appeared to demonstrate an acceptance of computer technology and perceived their own role as evolving into guiding more teachers in the school or of the future.

On the other hand, teachers need the necessary knowledge and competence in order to use computer technology effectively. Encouragingly, more than half of all teachers indicated to have participated in seminars and workshops that emphasize integration of computer technology in instruction. Despite this, teachers' computer technology knowledge and competence generally seems a serious problem. Effective training, teachers' computer technology experience and teachers' perceived computer competence would all affect teachers' perceived ease of use of computer technology. This would most probably be one of the top priorities that school administrations need to tackle in the future.

The issues surrounding computer hardware were found as the barriers affecting implementation. The respondents view the hardware factor as an accessibility barrier and contend that computer labs are an effective strategy for reducing the student-to-computer ratio in schools. They also contend that the accessibility to computer hardware may also be dictated by the subject being taught. In some instances, the physical location of computer and the students needing access to them acted as a barrier to teachers implementing the technology.

It was noted that real learning activities and hands-on mathematics are difficult to carry out in a computer laboratory. Most such activities require more room and equipment than staff members can haul into and out of a room not dedicated to such activities. Another issue identified in the study involves limitations of computer labs and issues of scheduling computer time. Teachers argue that computers need to be situated in classrooms where they can be easily accessed by students and used in a meaningful and pragmatic way. The barrier of limited accessibility prevents true integration of the computer in the instructional process.

Another factor that is identified by the teachers in the study is the lack of availability and access to software that is subject content appropriate. The study found out that the application of appropriate software and hardware to mathematics curricular specific computing was necessary. Primary to the implementation of the software is its assessment in terms of its use and appropriateness in the context of specific learning outcomes. Part of this articulation process is having curricular software and manuals catalogued and accessible for easy use by mathematics teachers. The teacher issues and potential barriers to implementation that are software resource related included matching courseware to curriculum, evaluation, quality control, acquisition, setting priorities, security, placement, and appropriate use.

This study found that one of the most frequently occurring and significant conditions affecting teachers' willingness to embrace computer technology in instruction was the lack of available preparation time for teachers to develop lessons that used computers. Time was viewed as an accessibility barrier. Individualized lessons, matching software to the curriculum, scheduling student computer time, monitoring use, providing assistance and troubleshooting were noted to add burdens to the teacher's time in the classroom. The net effect is increased demand on teacher's time and creativity and very few teachers have adequate time for planning and preparing to use the technology.

The need for teacher training on basic computer skills is expressed and explained by the fact that most of the presently hired teachers received little or no training in their formal education. It could also be a reflection of the need to update teachers' knowledge in the world of fast moving technology of communication. Training teachers on the educational use of computers gains special importance when considering integrating the computer into mathematics curriculum. Teachers need to know how to use computers first before they can integrate.

Most mathematics teachers were found to be reluctant to consider the implementation of computer in teaching. The relatively cautious position of the teachers is perhaps due to their limited experience with software and hardware and the uneasiness about changing their habits and techniques. The teachers are unprepared to use computers in their classrooms and they lack support and educational guidance. They point to professional development and training that will provide them with materials, strategies and new understanding to meet the learning goals as a solution to successful implementation.

The study reports that technologies have the potential to enrich the teaching and learning process but only under certain related conditions. These include adequate teacher training in the skills needed to operate the technology, a clear vision and understanding among educators of state-of-the-art development and applications, technical support for experimentation and innovation, time for learning and practice. The acquisition of computer expertise and skills is generally left to teacher initiative and thus there is need to provide adequate teacher training. Teachers will need continuing in-service programs as technology changes, as more effective uses of technology are developed, and as research provide a better understanding of how learning occurs. The teacher is central to the implementation of computers in the classroom. Adequate teacher training is necessary if that is to occur. Essential to teacher training is drawing a link between pedagogy and technology.

The study emphasizes the role of individual teachers in implementation of computers and how teachers can affect the educational appropriateness of the technology in mathematics. It was found that lack of sound pedagogical basis for integration of technology within the school has led to a narrow and unimaginative usage. The teachers and schools focus the use of computers on classes such as computer studies rather than in other subject areas and thus most study is of the technology rather than with the technology. The respondents contend that this practice has the effect of marginalizing computers in education.

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. As observed in the study, successful implementation of computers can only occur if administrators offer teachers support and leadership. 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 that 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 computer technology integration; and scheduling regular meetings among teachers using technology to plan and evaluate instruction.

7. Implications

The findings reported in this study have provided information on secondary mathematics teachers' use of computers. The research has found that mathematics teachers' use of computer technology is related to pedagogical factors such as knowledge and skills, perceived usefulness, access to technology hardware and software, and pedagogical routine practices. The findings shed light on how often teachers use computer technologies and indicate that a substantial majority of respondents felt less confident in teaching mathematics with this technology, although there were differences in confidence levels when using computers.

The study reports that computers are available in most schools in the districts. However, teachers find it difficult to gain access to computer laboratories for mathematics classes and this seems to disadvantage mathematics. In most schools computer laboratories are only reserved for students taking computer studies as a subject. 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.

There were additional connections between teachers' use of computers, professional development on their use, and positive beliefs about the role of this technology in supporting mathematics learning. Taken together, the findings regarding frequency of computer technology use and factors related to use seem to suggest that teachers view computer as a mathematics -specific teaching and learning resource, though not readily accessible. They also pointed out the need for targeted professional development to overcome their lack of experience with this technology.

These results also lead us to ask how mathematics teachers might best be supported in using computer technology effectively in instruction. Confidence grows with teaching experience, but a more proactive approach to increasing teachers' comfort with and use of computer technology needs to address issues of access to computers and professional development. The teachers' own perceptions of their professional development needs in this area centre on three issues: time, access, and technology integration. Time for professional development was an issue for most of the teachers as they indicated to need more time to develop resources, plan lessons and curriculum units, and explore and evaluate the technology, preferably in collaboration with colleagues. Teachers pointed out the need for regular access to a computer lab and appropriate software for instruction. But the most striking aspect was the large number of teachers who wanted professional development on how to effectively integrate computer technology into the teaching of mathematics, especially in the context of the syllabus or the school's teaching program. Most of these were interested in learning how to plan activities that combine computer technology with mathematical concepts in the lessons.

The findings presented in this paper have clear implications for resourcing of schools with respect to equipment and the preparation of teachers in ICT related pedagogy through in-service education and point to the need for curricular materials for teachers to learn to effectively integrate technology into their practice. 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.

There is need for support of school administrators and, in some cases, the surrounding community, for teacher use of computers as critical if computers are to be used. For this reason, targeted outreach to both groups is often necessary if investments in computer technology to support education are to be optimized. There is also need for adequate time to allow teachers to develop new skills, explore their integration into their existing teaching practices and curriculum, and undertake necessary additional lesson planning for computer use in instruction. More importantly, the government should aim at providing policies and protocols that facilitate the uptake and use of computers in schools by giving priority to teacher access to computer resources, professional development, quality digital content and computer infrastructure.

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