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Evaluation of Barriers to the Integration of ICT in Teaching and Learning of Science and Mathematics in Zimbabwe's Secondary Schools.

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ABSTRACT

This article examines the perceived barriers to information and communication technology (ICT) integration in science education. A questionnaire designed to elicit teachers' feedback was administered among 56 experienced male and female Science and Mathematics teachers within Zimbabwe. Initial results indicate that teachers had a strong desire to integrate ICT into education; but they encountered many barriers. The major barriers were lack of confidence, lack of competence, lack of electricity, lack of school funding and lack of access to resources. Recommendations made suggest that ICT resources including software and hardware, effective professional development, sufficient time, and technical support need to be addressed.

INTRODUCTION

There is an assumption that science teachers will be able to effectively use a range of information communication technology (ICT) related resources in the classroom in order to enhance student learning. All schools in Zimbabwe are in the process of encouraging teachers to use ICT in the classroom. The use of ICT in the classroom is very important for providing opportunities for students to learn to operate in an information age. Studying the obstacles to the use of ICT in education may assist educators to overcome these barriers and become successful technology adopters in the future.

Computers began to be placed in Zimbabwean schools in the 1980s. Modern technology offers many means of improving teaching and learning in the classroom (Lefebvre, Deaudelin & Loiselle, 2006). Dawes (2001) is of the view that new technologies have the potential to support education across the curriculum and provide opportunities for effective communication between teachers and students in ways that have not been possible before. ICT in education has the potential to be influential in bringing about changes in ways of teaching. However, this potential may not easily be realized, as Dawes (2001) underlined when he stated that “problems arise when teachers are expected to implement changes in what may well be adverse circumstances” (p.61).

Due to ICT’s importance in society and possibly in the future of education, identifying the possible obstacles to the integration of these technologies in schools would be an important step in improving the quality of teaching and learning. Balanskat, Blamire, and Kefala (2006) argue that although educators appear to acknowledge the value of ICT in schools, difficulties continue to be encountered during the processes of adopting these technologies.

Purpose of the Study

The purpose of this study was to evaluate the present and future barriers that face Science and Mathematics teachers in secondary schools in integrating ICT in the process of teaching and learning of Science and Mathematics in their schools. Studying the obstacles to the use of ICT in learning and teaching environments is crucial because this knowledge could provide “guidance for ways to enhance technology integration” and encourage greater use of ICT. Identifying the fundamental barriers may assist teachers and educators to overcome these barriers and become successful technology adopters.

Based on this analysis, the study provides recommendations on improving ICT integration in the teaching and learning of Science and Mathematics in Zimbabwean secondary schools.

Literature Review

Several studies argue that the use of new technologies in the classroom is essential for providing opportunities for students to learn to operate in an information age. It is evident, as Yelled (2001) argued, that traditional educational environments do not seem to be suitable for preparing learners to function or be productive in the workplaces of today's society. She claimed that organizations that do not incorporate the use of new technologies in schools cannot seriously claim to prepare their students for life in the twenty-first century. This argument is supported by Grimus (2000), who pointed out that "by teaching ICT skills in schools, the pupils are prepared to face future developments based on proper understanding"(p.326). Similarly, Bransford et al. (2000) reported that "what is now known about learning provides important guidelines for uses of technology that can help students and teachers develop the competencies needed for the twenty-first century" (p.206).

ICT can play various roles in learning and teaching processes. Wong et al. (2006) point out that technology can play a part in supporting face-to-face teaching and learning in the classroom. Many researchers and theorists such as Grabe and Grabe (2007) assert that the use of computers can help students to become knowledgeable, reduce the amount of direct instruction given to them, and give teachers an opportunity to help those students with particular needs.

While new technologies can help teachers enhance their pedagogical practice, they can also assist students in their learning.

The British Educational Communications and Technology Agency (Becta, 2003, p. 10), lists five factors which influence the likelihood that good ICT learning opportunities will develop in schools as follows: ICT resourcing, ICT leadership, ICT teaching, schools leadership, and general teaching. Becta (2003) also indicated that the success of the integration of new technology into education varies from curriculum, place to place, and class to class, depending on the ways in which it is applied. In science education, there are some areas where ICT has been shown to have a positive impact.

Potential benefits from the use of ICT for Science and Mathematics learning have been reported in several research studies. One of these potential benefits is the encouragement of communication and collaboration in science research activities. According to Gillespie (2006), new technologies can be used in science education to enable students to collect science information and interact with resources, such as images and videos, and to encourage communication and collaboration. Murphy (2006) reviewed the impact of ICT on the teaching and learning of science in schools. She indicated that “the Internet is used in science both as a reference source and as a means of communication” (p. 24). New technologies may also help to increase student motivation (Osborne & Collins, 2000), facilitate clearer thinking, and develop interpretation skills with data (Newton & Rogers, 2003).

Another benefit from using ICT in science education is that it expands the pedagogical resources available to science teachers. Pickergill (2003) explored effective ways of utilizing the Internet when teaching science. He found that the ease of Internet access allows teachers to help students to become experts in searching for information rather than receiving facts. He claimed it could “increase their [students’] awareness of the importance of the world around them, of citizenship and a scientifically literature community” (p. 86). Kelleher (2000) reviewed recent developments in the use of ICT in science classrooms. While he wrote that ICT cannot replace normal classroom teaching, the review indicated that ICTs could be positive forces in science and mathematics classrooms for a deeper understanding of the principles and concepts of science and could be used to provide new, authentic, interesting, motivating and successful educational activities.

The act of integrating ICT into teaching and learning is a complex process and one that may encounter a number of difficulties. These difficulties are known as “barriers.”

Participant teachers specifically starting to learn ICT require more time. These include the time needed to locate Internet advice,

prepare lessons, explore and practise using the technology, deal with technical problems, and receive adequate training.

According to Becta (2004), the issue of training is certainly complex because it is important to consider several components to ensure the effectiveness of the training. These include time for training, pedagogical training, skills training, and an ICT use in initial teacher training. Correspondingly, recent research by Gomes (2005) relating to science education concluded that lack of training in digital literacy, lack of pedagogic and didactic training in how to use ICT in the classroom, and lack of training concerning the use of technologies in science specific areas were obstacles to using new technologies in classroom practice.

Method

The present study, aimed at evaluating the barriers hindering the integration of ICT in the teaching and learning of Science and Mathematics, is the result of a survey conducted among 56 Science and Mathematics teachers in Zimbabwe's secondary schools who had registered for further training in the department of Science and Mathematics Education at the University of Zimbabwe.

Procedure

In the first week of their arrival, they were asked to fill in questionnaires consisting of selected statements on ICT to determine their knowledge, skills and attitudes in the subject area. ICT is one of the compulsory courses on their programme. Their responses to the questionnaire items were kept for 6 weeks while they received training in ICT. After training, the same questionnaires were administered again to assess whether the Science and Mathematics teachers had acquired new skills in the areas of: competence in using ICT resources, access to ICT resources and confidence and resistance to change. Comparisons were then made to determine whether there were any differences in knowledge before and after training.

*Results***Table 1.****Means and Standard Deviations Before and After Training in ICT Skills**

	After Training	Before Training	Sig. Level
	Mean (SD)	Mean (SD)	
How often do you assemble a computer generated text, data and graphics into an integrated report during your teaching?	6.21 (0.92)	4.41 (1.67)	<0.001
Have you ever used statistical software such as SPSS to analyse data?	5.93 (0.83)	4.64 (1.56)	<0.001
Do you use graphics software during your teaching to compile graphs and charts?	3.81 (1.72)	2.60 (1.58)	<0.001
Have you ever used a word processor to compile a project report?	4.79 (1.21)	3.14 (1.28)	<0.001
Do you teach your students to use the internet to conduct literature search?	4.40 (1.55)	3.05 (1.63)	<0.001
To what extent do you think all students should be computer literate?	5.56 (1.44)	4.50 (1.23)	<0.001

Choose from the list below what you consider to be the barriers affecting use of ICT in your school:	5.35 (1.04)	4.62 (1.38)	<0.001
Lack of ICT resources			
Lack of interest			
Lack of teacher confidence			
Resistance to change			
Lack of appropriate skills			
Insufficient time			

The male and female participants whose average age was 32 responded to the following items:

Findings and Discussion

The following discussion focuses on the relationships between lack of accessibility and lack of competence and other factors such as time, funding, training and technical support.

There are multifaceted relationships between the barriers. Some barriers such as lack of teacher competence and lack of accessibility to ICT resources seem to be closely related. Some barriers such as lack of teacher confidence and resistance to change seem to be more significant than others. The lack of accessibility to resources as a barrier is closely related to several other key issues which can themselves be considered barriers to teachers' use of ICT. Although the resources are available in 70% of the schools, the ICT resources are not sufficient. Only 10% of the schools have ICT resources in the Science and Mathematics departments. 90% of the schools just have a computer room with less than 10 computers for the whole school. Lack of time due to Science and Mathematics teacher shortages does not allow teachers to access these resources. In some cases there was only one science teacher per school. Where technical equipment was available there was no time for the teacher to operate and review

those equipments. This was because the numbers of lessons per day per teacher were too high.

Lack of teacher training reduced the integration of technology in the teaching and learning of Science and Mathematics. Educational technological materials in some cases were available in schools but teachers cannot use them because of a lack of pedagogical or skills-related (practical) training in how to use these ICT resources. On the other hand, it may be that the lack of access to resources leads to a reduction in training opportunities. Teachers again only had access to ICT resources only at school and none had access at home.

Teachers in 90% of the schools had no technical assistance. Technical support helps in training and training takes time. Together they allow access to ICT resources and thus help the successful integration of technology in the teaching process.

Lack of competence was of the most common obstacles to teachers' use of technology in the teaching of Science and Mathematics. The first problem linked to the competence barrier was the lack of training or effective training. 93% of the teachers had no basic skills in using ICT technology as well as training in the integration of this technology into interactive and effective teaching.

None of the schools give teachers time to develop their ICT skills. It's all up to the teachers to fund their training and this has to be done outside working hours.

The relationship between access to modern technological resources and the competence of teachers to use them is complicated. This relationship links those factors with other issues such as time, training, and technical support. Also, there is a relationship between the barriers of lack of accessibility and lack of competence. In other words, teachers may not be able to access ICT resources unless they have skills in the use of technology and can work with it efficiently in their teaching. On the other hand, access to ICT resources can help teachers increase their competence whether by self-training

through the internet or by communication with experts. The opportunities for development of teachers' skills and their access to ICT resources can be increased by providing them with technical support and sufficient time. None of the schools provides teachers with technical support.

The lack of confidence is a problem linked to the previous two issues the lack of access to resources and the lack of teacher competence. Regarding the availability the resources, perceived ability to use ICT and having the basic skills to operate it may increase teachers' satisfaction with modern technologies, which may motivate teachers to integrate ICT in education. 99% of the teachers lack confidence when it comes to the use of ICT equipment during the teaching and learning process.

Understanding the levels in this study at which these barriers prevent teachers from using ICT may help educators to decide how the barriers can be tackled. In other words, teachers should be convinced of the importance of using ICT in the classroom. Then, they should be provided with access to resources. After that, teachers need to be able to use these resources successfully. Access to ICT and the ability to use it cannot be possible without sufficient time, effective training and technical support.

Implementation

One can see that it is much easier to remove barriers by resolving and reducing the reasons for the occurrence of these barriers. Educators, teachers, and school headmasters need to collaborate to overcome any of the obstacles and break down the above mentioned barriers to the meaningful integration of ICT into teaching and learning.

Schools need to provide training courses for teachers to gain experience in dealing with the new devices, modern technologies, and new pedagogical approaches. Technical support needs to be

provided in schools. Additionally, schools must provide teachers with the necessary ICT resources including hardware and software. It is important for schools to cooperate with teachers by providing sufficient time to implement new technologies in the classroom. For example, a school can reduce the teacher's number of lessons.

Teachers also need to play an active role. Teachers should take advantage of ICT resources offered at schools. They need to be prepared well before joining the teaching profession. Where training is absent, teachers can prepare themselves by enrolling in private sessions or by self-training. They should be open minded towards new approaches of teaching. Where support is lacking, they need to find ways to be able to solve problems involving their use of ICT in their schools. Finally, teachers should acquire skills of self-organisation which will help them a great deal in conducting their classes when using ICT.

Conclusion

The aim of this study was to provide information on encouraging the desired improvement in the future teaching situation to those responsible for the integration of ICT into science education. The findings of this study indicate that teachers have a strong desire for the integration of ICT into education but that they encountered many barriers to it. The major barriers were lack of confidence, lack of competence, and lack of access to resources. Since confidence, competence and accessibility have been found to be critical components for technology integration in schools, ICT resources including software and hardware, and effective professional development, sufficient time, and technical support need to be provided for teachers. No one component in itself is sufficient to produce good teaching. However, the presence of all components increases the likelihood of excellent integration of ICT in learning and teaching opportunities.

Recommendations

The study makes the following recommendations:

- Teachers require ICT training so that they are competent when using computers in the teaching and learning of Science and Mathematics in Zimbabwean secondary schools.
- Access to resources related to ICT should be increased or be available such as computers, flash disks, printer, smart boards, projectors etc to practicing teachers.
- Technical support needs to be provided for teachers in order to make it possible them to always have their ICT equipment ready for use.
- Effective professional development must be offered to teachers always since in this field of ICT there are quick changes that take place from time to time.
- Poor school funding must be addressed in most schools so that they are able to sustain ICT in the teaching and learning of Science and Mathematics.
- More Science and Mathematics teachers are needed in schools in order to give teachers' teaching loads.

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