THE CHALLENGES OF INTEGRATING ICTS INTO THE MATHEMATICS CURRICULA IN THE SADC REGION: THE CASE OF BOTSWANA

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ABSTRACT

The assumption for this paper is that mathematics is a problematic area for teachers and learners alike in the SADC countries. It reflects the author's efforts in embarking on finding ways to help teachers make the curriculum more engaging to promote students' conceptual understanding emanating from mathematical processes rather than procedural knowledge.

The paper reflects the author's efforts to integrate ICTs, specifically computers, into the Botswana Mathematics Curriculum and the challenges thereof by reporting on how mathematics teachers who have acquired the skills of using computers in the Mathematics curriculum are coping in schools. The work derives from action research where teacher-trainees (student-teachers) are exposed to a variety of strategies for using computers to teach mathematics and then followed up in the field to gauge the challenges they face when using the strategies.

Three operational issues were conceptualized by the teachers as challenging in their endeavours to use ICTs to teach mathematics, namely limited access to resources, inadequate time allocated to mathematics and lack of administrative support. These factors were reportedly demoralizing teachers, making them lose confidence and falling back on the traditional absolutist teaching strategies common in Botswana classrooms (Prophet, 1995; Tabulawa, 2002).

Findings from several recent studies indicate that ICTs such as computers can play an important role in motivating young people and encouraging them to engage in learning, within and beyond the classroom. Botswana's three-year junior and two-year senior secondary schools' mathematics syllabi emphasise developing learners' computer skills and an appreciation of the role of modern technology in mathematics.

The Botswana Education system has adopted a postmodernist education approach whose main underlying learning theory is Constructivism which prompted the author's desire to equip mathematics teachers with the skills and knowledge of employing the use of computers in mathematics teaching and learning.

Keywords: Botswana education, ICTs, mathematics curriculum, challenges, constructivism, computers

INTRODUCTION

Rationale for the Paper

The paper derives from the premise that students in the SADC region rate very low in mathematics in international standardized testing such as TIMMS, SACMEQ, etc. which makes it possible to assume that it is a problematic area for teachers and learners in the region. One can only conclude that traditional absolutist teaching methods have not succeeded in changing learners' attitudes towards the subject.

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 4 No. 2 March 2013

The paper reports on efforts to integrate ICTs, particularly computers, into the Botswana mathematics education system to foster students' interests in learning mathematics and the challenges thereof. The basis of the paper also stems from the assertion that teachers often teach as they were taught (Bennet, 1991) and that pre-service teachers often perceive the knowledge and practice of school-based teachers in their field experiences as more reliable to that of their teacher educators (Britzman, 1991).

RESEARCH QUESTION

Based on the outlined assumptions, the research question for the study is: *"What challenges have practicing encountered in their efforts to integrate computers in the teaching and learning of mathematics in their respective schools?"* The objective was to find out how the mathematics teachers were coping when using computers to teach mathematical concepts. This would make it possible to identify the challenges that the teachers faced both at school and classroom level.

THEORETICAL/CONCEPTUAL FRAMEWORK

The study is guided by a postmodernist learning theory that supports the integration of new technologies in education whose main underlying learning theory is Constructivism. This is the education philosophy being advanced lately by the Education systems of the SADC bloc of countries through pronouncements in their mathematics curricula and syllabi to counter traditional education environments which do not seem to be suitable for preparing learners to function or be productive in the workplaces of today's society (Yelland, 2001).

Botswana's Junior Certificate of Education (JCE) syllabus (p. iii) and the Botswana General Certificate of Secondary Education (BGCSE) syllabus (p. i) pronounce that to achieve their aims and objectives, the teaching and learning of Mathematics has to be based on a learner centred approach. Consequently, a variety of learner centred methods such as exposition and consolidation, discussions, practical work, problem solving and investigative work are proposed to be used. Furthermore, teaching and learning of mathematics is envisaged to utilise modern technologies such as graphic calculators and computers that place mathematics in a realistic context. The syllabi aims state that this will offer a constructivist view on mathematics to learners, promote interest and motivation, and prepare the students effectively for the next century paving the way for future generations.

In the same vein, the author advances the fallibilist philosophy about the nature of mathematics (Ernest, 1994), that sees mathematical knowledge as fallible, subject to revision, and a construction of human kind. This advocates for the teaching of mathematics focusing on open-ended investigations of concepts. This is essentially the social constructivist/constructionist perspective about learning (Kafai & Resnick, 1996) which sees knowledge as personally and socially constructed; learning as learner-centred, situated, authentic, and achieved by designing and making personally meaningful artifacts; which calls for the promotion of multiple perspectives and representations of knowledge at classroom level.

The basic idea of the fallibilist philosophy is that all knowledge is invented or "constructed" in the minds of people, and that the ideas teachers teach and students learn do not correspond to "reality," but are merely human constructions. From this theoretical perspective, it suffices to say that knowledge, ideas and language are created by people, not because they are "true," but rather because of their usefulness. This suggests that, unlike in the past, learners no longer learn mathematics to understand and enjoy mathematical 'truths' and theories, but to be able to use the learned concepts in solving real world problems. ICTs such as computers have become essential tools for the advancement of such mathematical concepts, and have been

found to provide opportunities for students to learn to operate in an information age (Bingimlas, 2009).

For the reader to understand why the integration of computers in the Mathematics Curricula of the SADC region is described as challenging, conceptualising '*challenge*' becomes a fundamental aspect of this study. There are many facets of the word 'challenge' and there is need for its contextualization for better understanding. By 'challenge' in this paper is meant 'A test of one's abilities or resources in a demanding but stimulating undertaking' (The American Heritage® Dictionary of the English Language, Fourth Edition copyright ©2000) or some 'difficulty in a job or undertaking that is stimulating to one engaged in it' (Dictionary.com).

Operationalising '*challenge*' has proved somewhat difficult for the author because some concepts viewed as challenging may appear to others as '*common knowledge'*. For instance it is common knowledge that developing countries' education systems such as found in the SADC region, Botswana included, are under-resourced. The study identified three main concepts on which 'challenge' could be operationalised, namely: *limited access to technology* (computers), the *inadequate time* and *lack of administrative support*. The respondents found these to slow down progress in their ambitious endeavours to integrate technology into their practice.

METHODOLOGY

This is an exploratory, action research based reflection of the author's efforts to integrate ICTs into teaching and learning mathematics. The author, as part everyday practice, provides teacher-trainees with a variety of strategies for using computers to teach mathematics to complement traditional (absolutist) methods common in Botswana classrooms (Rowell & Prophet, 1990; Prophet, 1995; Tabulawa, 1998, 2002) and then follow them after deployment into schools to find out how they cope when employing the strategies.

The data collection for this study was undertaken during the Teaching Practice (TP) assessment period from May 2011 to July 2011. A semi-structured interview schedule was used to solicit information on how the researcher's former students (who were at the time serving teachers) were incorporating computers in classroom practice and the challenges they encountered. The interviews lasted for a maximum of thirty minutes each session and follow-up sessions were scheduled as need arose.

A total of 30 mathematics teachers were interviewed from three regions of Botswana designated as Northern (Francistown), Central (Palapye and Mahalapye) and Southern (Molepolole and Lobatse). Twelve of the teachers were in senior secondary schools and the remaining 18 were in junior secondary schools. From each region the population sample came from two senior secondary schools and three junior secondary schools. Two teachers were randomly selected from each of the six senior secondary schools and two from each of the nine junior secondary schools. The researcher was assigned candidates for teaching practice assessment in the said regions and 'convenient sampling' of schools was used.

As has been mentioned earlier, the interviews were based on the research question: *"What challenges have you encountered in your efforts to integrate computers in the teaching and learning of mathematics in your school?"* The interviews also sought information on the availability of ICTs in the schools, and on problems related to connectivity (internet, etc) and maintenance. This was to take cognisance of the fact that the government of Botswana has embarked on a developmental strategy of connecting all schools to the internet facility to meet Vision 2016's 'informed nation' strategy.

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 4 No. 2 March 2013

The interviews were audio-tape recorded and transcribed. Immediately following each interview, the researcher identified a convenient place and audio-tape recorded a debriefing discussion to triangulate impressions and interpretations and to provide a record of emergent theories and ongoing focusing questions. Related themes and categories were put together in order to attach meaning and to make interpretations of the findings possible.

FINDINGS OF THE STUDY

As already mentioned, several factors were identified as affecting teachers' use of technology in Botswana mathematics classrooms, but three themes emerged of operational concepts of particular concern to teachers, namely:

1. Lack of or limited access to computers
2. Inadequate contact time for teaching mathematics
3. Lack of administrative support

Other factors, some of which resulted from the above, included lack of teacher confidence, lack of teacher competence in using computers, negative attitudes towards technology, resistance to change and lack of technical support. The reader need be reminded that the teachers involved in the study had taken the researcher's courses on some aspects of using computers to teach mathematical concepts. These emerging issues are elaborated below with meanings and interpretations attached as the author deemed it fit.

Access to Computers

Most teachers reported having had little or no access to computers in their respective schools. In the majority of cases, the computers were out of bounds for subjects other than Computer Awareness (junior secondary) or Computer Studies (senior secondary).

As mentioned earlier, this might appear to be 'common knowledge' yet all schools in Botswana were provided with computers for use across the curriculum. Other underlying factors may be that teachers themselves are not keen to use computers as this demands more time and commitment and in some cases because of lack of adequate skills in the utilization of available software for the teaching and learning of mathematics.

Many teachers complained that computers in their schools were not connected to internet or that the connection was not reliable because of sporadic electricity blackouts. This hindered their efforts to use the Internet to create instructional materials, access model lesson plans or access research and best practices. However, for those schools with access to internet, most teachers could not use computers to teach mathematics due to school policies denying them that opportunity. Only five senor secondary school teachers reported being allowed to use computers for mathematics lessons without restrictions, which formed only 10% of the sample.

Availability of Time Allocated To Mathematics

The teachers in this study reported inadequate student/teacher contact time for mathematics and that this hindered their efforts to improvise using available computer technologies such as their personal laptops and projectors. They alluded to the fact that to use computers for teaching purposes, they required enough time to allocate certain topics to technology use.

They complained that most of their time is spent on administrative tasks such as the Performance Management System (PMS) and the rest to assessing students' work. Accordingly, mathematics needed more time (particularly double periods) if the integration of computers in the subject is to succeed. This lack of time made some teachers give up on

efforts to use technology for teaching and learning and resort to the more popular traditional methods that Tabulawa (1998, 2002) and others have alluded to.

Administrative Support

Some teachers expressed concern that regardless of their requests to have departmental computers with projectors for use in mathematics classrooms, this has not been achieved on the grounds that 'funds are not available'. Their requests to schedule some of their mathematics lessons in the computer laboratories have not garnered support from the administrators, and they expressed disappointment at such developments which frustrate their ambitions to use computers for teaching purposes.

It should be noted that those teachers who reported having access to computers for teaching in their schools alluded to students' increased interest in mathematics lessons. Although the increment on outputs (performance) was negligible, the teachers were happy that at least they could attract more students to their mathematics lessons than ever before due to the introduction of computers in some of their lessons. Some teachers complained that technical problems such as failing to connect to the internet, waiting long periods for websites to open, printers not printing, malfunctioning computers, and teachers having to use old computers, discouraged many from using computers for teaching and learning.

CONCLUSION

It became apparent from the respondents that their efforts to use computers to teach mathematics were being frustrated from many fronts. There are many challenges that the teachers alluded to, but 'lack of access to computers, inadequate contact time for mathematics, and lack of support from administrators' were major issues of concern. This is despite several studies on ICTs and learning pointing to its great potential to enhance students' achievement and teacher learning (Bransford et al., 2000). Several researchers and theorists assert that computers can help students become knowledgeable, reduce the amount of direct instruction given to them, and give teachers an opportunity to help those students with particular needs (Iding, Crosby & Speitel (2002); Shamatha, Peressin & Meymaris (2004); Romeo, 2006). This has encouraged the author to continue to impart knowledge on the use of computers to teach mathematics to the pre-service teacher-trainees at the University of Botswana.

The author believes that the challenges are not insurmountable and that more persuasive strategies need be employed in the hope that more teachers will in the near future be able to use computers for teaching mathematics. The author agrees with the view that technology has permeated our educational experiences and as educators seek viable ways to use technology to enhance teaching and learning experiences, colleges must also prepare future teachers to plan for effective technology use (Wright, Wilson, Gordon and Stallworth, 2002). Some have argued that teacher preparation programs should not only integrate technology throughout the curriculum, but should also provide opportunities for the students to manage problems within the actual school setting as they integrate various tools of technology.

It is incumbent upon education authorities to provide teachers with all the necessary tools that could enhance their teaching profession. It is the researcher's belief that teachers are more likely to integrate computers and the Internet into classroom instruction if they have access to adequate equipment, connections, and the proper amount of preparation and training (NCES, 2000). The current situation as reported by the teachers of mathematics in Botswana is regrettable as we advance into the twentieth century.

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 4 No. 2 March 2013

In the final analysis, as Becker (1991) asserted, for computers to make a difference in how students experience schooling will require teachers and administrators to modify their concepts of appropriate and inappropriate behaviours, to reprioritize the value of different types of instructional content, and to change habits and assumptions that guide their classroom and school management strategies. In all this, professional development in the integration of ICTs in teaching and learning will be a key factor.

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