Barriers and Challenges Teachers Face with Integrating ICT in Mathematics Teaching

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Abstract

The purpose of this study is to explore the barriers preventing the integration and adoption of Information and Communication Technology (ICT) in teaching mathematics. The data were collected by means of questionnaires from secondary school mathematics teachers of Bhubaneswar. Major barriers were identified: lack of time in the school schedule for projects involving ICT, insufficient teacher training opportunities for ICT projects, inadequate technical support for these projects, lack of knowledge about ways to integrate ICT to enhance the curriculum, difficulty in integrating and using different ICT tools in a single lesson, and unavailability of resources at home for the students to access the necessary educational materials. To overcome some of these barriers, this paper proposes an e-portal which is a collection of mathematical tools, a question bank and other resources in digital form that can be used for teaching and learning mathematics. Based on these findings, I propose the use of several strategies that should enhance successful ICT integration.

Introduction

Information and Communication Technology (ICT) has changed our daily activities in many ways. One of the goals for integrating ICT in education is to enhance teaching and learning practices, thereby improving quality of education (Higgins, 2003). However, in most developing countries like India, the potential of ICT to support pedagogy is yet to be fully realised. Since these changes are more evident among younger members of our society and considering that ICT plays an increasingly important role in society, especially if we take into account social, economic and cultural role of computers and the Internet, it is clear that the time has come for the actual entry of ICT in the field of education. The combination of ICT and the Internet certainly opens many

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opportunities not only for creativity and innovation, but also for carrying the teaching material to current generation of students. Researchers argued that with the introduction of technology, it is possible to de-emphasise algorithmic skills; and the resulting void may be filled by an increased emphasis on the development of mathematical concepts. Technology saves time and gives students access to powerful new ways to explore concepts at a depth that has not been possible in the past. ICT enhances efficiency of mathematical thought, enables learners to make conjectures, and immediately test them in non-threatening environment (Laborde, 2001). Abramovich's (1999) use of spreadsheets in generalising Pythagorean Theorem demonstrates how computers may be used to learn concepts in geometry and algebra. Meanwhile researchers (Balacheff and Kaput, 1996; Kilpatrick and Davis, 1993) have discussed the impact of technological forces on learning and teaching mathematics. Internet is increasingly being used to enhance collaborative and interactive learning (Cazes, Gueudet, Hersant and Vandebrouck, 2006; Cress and Kimmerle, 2008; Resta and Rafferriere, 2007) also (Lavy and Leron, 2004). As the study and practice of facilitating learning and improving performance (Januszewski and Molenda, 2008), the field of educational technology attempts to overcome challenges by developing new approaches and frameworks. In this context, Information and Communication Technologies (ICTs)

represent a new approach for enhancing the dissemination of information and helping to meet these challenges. For a successful integration of ICT into the mathematics curriculum, it is essential to have knowledge of the existing software that is used by mathematics teachers. A survey carried out by Forgasz and Prince (2002) found that 61 per cent of the respondents (teachers) used spreadsheets, 45 per cent used word processing and 30 per cent used Internet browsers. In a separate study, Jones (2004) found that seven barriers existed while integrating ICT into lessons. These barriers were (i) lack of confidence among teachers during integration(21.2 per cent responses), (ii) lack of access to resources (20.8 per cent), (iii) lack of time for integration(16.4 per cent), (iv) lack of effective training (15.0 per cent), (v) facing technical problems while the software is in use (13.3 per cent), (vi) lack of personal access during lesson preparation (4.9 per cent) and (vii) the age of the teachers (1.8 per cent).

Methodology

This research deployed a survey method to investigate the barriers of integrating ICT into the teaching of mathematics. A total of 50 responses were received and they were analysed using the SPSS statistical package. A questionnaire was adapted from the Teacher Technology Survey by the American Institute for Research (AIR, 1998). The questionnaire was divided into five areas, i.e., (A) the teacher's profile, (B) how teachers use ICT, (C) the teacher's ICT experience, (D) the barriers faced by teachers and (E) the proposed solution.

Results and Discussions

ICT Applications in General

In general, a total of 74.3% of the respondents used computers on a regular basis. Table 1 depicts the percentage of usage by teachers in the various ICT applications: word processing packages (76.8%), spreadsheets (50.3%), Internet activity (67.2%), search engines (56.5%) and multimedia (11.2%). These percentages show that the computer literacy rate among secondary school mathematics teachers has been high.

8.6 per cent used it in discussion forums and 4.5 per cent for other purposes. 6.9 per cent respondents did not use the Internet.

Professional Development and Training Needs

A total of 40.3 per cent respondents indicated that they had received ICT training. 60.2 per cent of the respondents demonstrated that they had found the training to be generally useful while 64.9 per cent said that they had not received training on how to integrate ICT

Table 1: Common ICT Applications by Teachers

NA – Not Available; NR – No Response

Application	Daily (%)	Weekly (%)	Monthly (%)	1 or 2 times a year (%)	Never (%)	NA (%)	NR (%)
Computers in general	22.3	25.2	26.8	12.5	6.2	4.2	2.8
Word processing packages	20.4	26.3	30.1	13.6	5.8	1.3	2.5
Spreadsheets	9.6	15.4	25.3	22.5	6.3	12.5	8.4
Any Internet activity	20.8	22.5	23.9	28.6	1.2	1.3	1.7
Search engines for Internet	14.4	19.8	22.3	26.9	11.5	3.6	1.5
Multimedia	2.5	3.6	5.1	15.8	40.1	19.5	13.4

Uses of Internet

The Internet was used for various purposes. 65.5 per cent respondents

into mathematics teaching. According to 46.3 per cent of the respondents, mathematics teachers require training

Table 2: Use of Internet by Teachers

Activity	Browsing	e-mail	IRC	Discussion forums	Chat rooms	Others	None
Response (%)	65.5	42.3	5.5	8.6	6.3	4.5	6.9

used it for browsing, 42.3 per cent used the e-mail facility, 5.5 per cent used IRC (Internet Relay Chat), 6.3 per cent used chat rooms, and

Table 3: ICT Training Needs

ICT training needs	General use	Integrate ICT into teaching	Use of Internet	Combination of needs
Response (%)	10.1	64.9	5.5	59.5

on how to integrate ICT into their teaching, while 59.5 per cent of them stated that they needed a combination of various types of training.

Barriers faced by Teachers During Integration

The six major barriers identified were lack of time in the school schedule for projects involving ICT (50.3 per cent), lack of knowledge about ways to integrate ICT to enhance the curriculum (49.5 per cent), lack of adequate technical support for ICT projects (41.9 per cent), inadequate teacher training opportunities for ICT projects (41.2 per cent), integrating and using different ICT tools in a single lesson (34.8 per cent) and the absence of access to the necessary technology at the homes of students (31.0 per cent).

Perception of Mathematics Teachers Toward the Proposed Solution

There is a very strong positive response to the proposed solution to develop a mathematics portal for teaching mathematics, which is a collection of mathematical tools, a question bank and other resources in digital form that can be used for teaching and learning mathematics. 70.2 per cent

Table 4: Barriers Faced by Teachers

Barriers	*% Response as*		
	not a barrier	*minor*	*major*
Not enough teacher training opportunities for ICT projects	18.7	40.1	41.2
Lack of knowledge about ways to integrate ICT to enhance curriculum	10.2	40.3	49.5
ICT integration is not a school priority	31.4	45.2	23.4
Students do not have access to the necessary technology at home	22.8	46.2	31.0
Teachers do not have access to the necessary technology at home	24.9	55.2	19.9
Integrating and using different ICT tools in a single lesson	16.5	48.7	34.8

Table 5: Perceptions towards the proposed solution

	% response as very useful and helpful	*% response as useful and helpful*	*% response as not so useful and helpful*	*% response as not at all*
Proposed solution to develop a mathematics portal for teaching	70.2	27.3	2.5	0

of the respondents considered it to be very useful and helpful and 27.3 per cent viewed it as useful and helpful. Only 2.5 per cent of the respondents considered that the portal would not be very useful and helpful.

Findings

From this study, the following findings were found:

1. The most popular application packages used by mathematics teachers were word processing packages (76.8 percent), spread-sheets (50.3 per cent), Internet activity (67.2 per cent), and search engines (56.5 per cent). However, it must be noted that the packages that have not been positively considered by the respondents may not be necessarily useless. Mathematics teachers need more time to learn to use them — programmes like specific Java applets, Flash presentations, graphical applications and simulation programmes have great potential for the teaching of mathematics because they encourage explorations and higher order thinking.

2. It is encouraging to learn that 65.5 per cent of the respondents used the browser to gather information. It is time that educators encourage mathematics teachers to use the Internet for online demonstrations like using Java applets on mathematics that are only available online.

3. A large proportion (64.9 per cent) did not have any training on how to integrate ICT into mathematics teaching. Such training should be an integral part of professional training. Moreover, 46.3 per cent of the respondents requested to have training on how to integrate ICT into teaching.

4. Some major barriers hindering the implementation of ICT in mathematics teaching were found to be: lack of time in the school schedule for projects involving ICT; insufficient teacher training opportunities for ICT projects; inadequate technical support for these projects; lack of knowledge about ways to integrate ICT to enhance the curriculum; difficulty in integrating and using different ICT tools in a single lesson; and unavailability of resources at home for the students to access the necessary educational materials. Therefore, funding for new ICT resources should be increased in order to provide adequate ICT equipment and resources. It is also recommended that the contents of the subject be reduced so as to integrate ICT. Teachers consider that inadequate time is a factor against teaching and learning effectiveness.

5. Therefore, to encourage more teachers to integrate ICT into mathematics lessons, the devised programme must be user friendly. The e-portal proposed for this purpose is geared towards fulfilling such needs. This e-portal will be a collection of mathematical tools, a question bank and other resources in digital form that can be used for teaching and learning mathematics.

Use of ICT in Teaching-Learning Process

ICT has the potential to make a significant contribution to pupil's learning in mathematics by helping them to:

(i) practise and consolidate learning skills by using software to revise and give rapid assessment feedback.

(ii) develop skills of mathematical modelling through exploration, interpretation and explanation of data, by choosing appropriate graphical representations for displaying information from a data-set; by experimenting with forms of equations in trying to produce graphs which are good fits for data-plots; by using a motion sensor to produce distance time graphs corresponding to pupils own movements.

(iii) experiment with, make hypothesis from, and discuss or explain relationships and behaviour in shape and space, and their links with algebra, by using software to

(a) automate geometric construction

(b) carry out specified geometric transformations

(c) perform operations on coordinates or draw loci.

(iv) develop logical thinking and modify strategies and assumptions through immediate feedback by planning a procedure as a sequence of instructions in a programming language or a sequence of geometrical constructions in geometry software or a set of manipulations in a spreadsheet.

(v) make connections within and across the areas of mathematics, for example, to relate a symbolic function, a set of values computed from it, and a graph generated by it to a mathematical or physical situation, such as the pressure and volume of a gas, which it models.

(vi) work with realistic and large sets of data.

For example, carrying out experiments using large random samples generated through simulations.

(vii) explore, describe and explain patterns and relationships in sequences and tables of numbers, by entering a formula in algebraic notation to generate values in an attempt to match a given set of numbers.

(vii) learn and memorise by manipulating graphic images. For example, the way the graph of a function such as $y= x2$ is transformed by the addition or multiplication by a constant.

ICT also has the potential to offer valuable support to the mathematics teachers by:

(a) helping them to prepare teaching materials.

For example, downloading materials for classroom use from the Internet, such as mathematics problems for pupils to solve with accompanying teachers' notes, software for computers and reviews of published resources.

(b) providing a flexible and time-saving resource that can be used in different ways and at different times without repetition of the teachers' input by enlarging fonts, adding diagrams or illustrations, adapting parameters used in problems.

(c) providing a means by which subject and pedagogic knowledge can be improved and kept up-to-date by accessing the virtual teacher centre to obtain practical advice, to exchange ideas with peers and 'experts' outside school.

(d) aiding record-keeping and reporting by storing and regularly updating formative records which can form the basis of a subsequent report.*

Conclusion

To create an environment of effective ICT integration, hence improving the quality of education for the youth in the province, teacher education programmes must focus on eliminating barriers. Based on the findings and discussions presented here, the following recommendations are suggested for practitioners.

1. Technology plans for implementing ICT should be prepared and implemented.

2. Training in ICTs for teacher educators should be improved in both quantity and quality.

3. Every classroom should have at least one computer with Internet access and an LCD projector.

4. Course content should be redesigned to acquire more benefit from ICT.

5. More ICT-related courses for prospective teachers should be offered.

6. Teacher educators and prospective teachers should be aware of the benefits of ICTs.

7. An e-portal, collection of mathematical tools, a question bank and other resources in digital form that can be used for teaching and learning mathematics should be constructed.

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