

THE BENEFITS AND CONSTRAINTS OF THE USE OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) IN TEACHING MATHEMATICS

BY

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Abstract

All the nations of the world are embracing technological innovations and integrating them into their educational system for advancement and development. The use of information and communication technology (ICT) in mathematics teachers training has been verified to ascertain if it will serve as a catalyst for change in the teaching and learning of mathematics. The objectives of this systematic analysis is to explore the benefits, the barriers preventing the integration and adoption of information and communication technology (ICT) in teaching mathematics based on selected literature, it was found that the advantages of applying ICT in teaching mathematics are: it attracts students interest in learning mathematics, it increases their motivation and performances. Six major barriers were identified; lack of time in the school schedule for project involving ICT, insufficient teacher training opportunities for ICT projects, inadequate ICT to enhance the curriculum. To overcome some of the barriers, this paper proposes there is a need for an increase in training for mathematics educators in terms of computer usage and ICT applications for teaching purposes. Technical support should also be a concern, so as to motivation mathematics educators to apply elements of ICT in their teaching. This could maintain the positive changes and perception of students regarding learning mathematics.

INTRODUCTION

Life without the knowledge of mathematics would have been very difficult because mathematics is an important subject for the aspiration of scientific and technological development. No nation in the world has ever developed technologically without putting mathematics in appropriate position. Most advances in science and technology owe their origin to mathematics. Which is often referred to as the language of science and technology. For example, the computer, which is the greatest discovery of the last counting owes its origin to mathematics theories

Whatever problem is solved today by applying computer technology has been solved by mathematics in the past. No wonder the place of mathematics among the subjects taught in Nigerian schools is well recognised (Olagunju and Lawal 2015).

Mathematics is a natural complementary discipline for learning and appreciating science concepts. Accordingly, for the student's benefits, Foundational mathematics should be introduced early and integrated throughout the curriculum.

Information and communication technology (ICT) is a very broad area of instructional communication support. It involves the use of computers, autograph, cabric 3D, software and other software's that assist students in learning.

Ittigon and zewe (2003) cited that technology is essential in teaching and learning mathematics. ICT improves the way mathematics should be taught and enhances students understanding of basic concepts. Students would then use technology to concentrate on problem solving processes rather than on calculations related to the problems (Ittigson & Zewe, 2013)

Information and Communication Technology (ICT) is a combination of devices and technology resources, which are used to manipulate and correlate information (Kaware & Sain, 2015). The usage of ICT is becoming more crucial in education as it enables the development of a more proactive teaching and learning environment (Gabare *et al.*, 2014, Daud & Khalid, 2014). Together with the expansion of current era of technology, educators are encouraged to incorporate ICT into their teaching, as a substitute for traditional teaching methods (Kiflee & Khalid, 2014).

ICT is not only a tool for teaching and learning, but also acts as a driving force for an educator to play his or her role in education (Nur Qistina & Hazman, 2006). For example, the application of ICT could expose students to various skills linked to their future needs, such as using Microsoft Word, email, and the internet for lifelong learning processes (Gabare *et al.*, 2014; Khalid, 2014; Jones, 2011). Furthermore, the application of ICT can help educators to obtain resources from outside their networks, thus enabling them to transform the teaching and learning process.

The application of ICT is intended to refine and elevate both students' learning and educators' teaching qualities (KPM, 2013). In addition, it is a process of fitting technology to various

learning and teaching conditions, whether inside the classroom or outside (Norazrena & Khairul Anuar, 2011; Nur Qistina & Hazman, 2006).

Moreover, the integration of ICT in education could increase students' competence based on global needs through skill shaping and increasing knowledge (Storm, 2011), as well as able to enhance students' cooperative learning through community of practice (Khalid *et al.*, 2013, 2014).

Indirectly, ICT has become an important means for educators to acquire teaching resources in the form of simulations, notes, exercises, brainstorming, and information sharing.

Other research shows that technological integration in teaching mathematics includes the use of Microsoft Excel, DERIVE, MATHEMATICA, and MAPLE software for algebra (Keong *et al.*, 2005; Neurath & Stephens, 2006). The use of Microsoft Excel facilitates students to carry out algebra-related problem-solving, such as constructing equation graphs, finding the slope of a straight line, and simplifying equations. MAPLE is also used to aid students in constructing equation graphs in algebra.

Learning software is also being developed based on certain topics in mathematics. For instance, the development of computer-based software for the topic of fractions is based on the ASSURE learning model. In addition, mathematical software for special education students is constructed based on the ADDIE learning model. Both of these types of software function as a medium for additional exercises and to acquire notes for the topic of fractions. Students are able to repeat exercises multiple times and obtain direct feedback from the website (Norazrena & Khairul Anuar, 2011).

Applications of ICT in Mathematics

There are some applications of ICT that have been used by teachers in the teaching and learning of mathematics, whether for secondary schools or for primary schools. These applications act as teaching aids for teachers and revision materials for students, either during the lessons in schools or at home. ICT applications also help students in doing their assignments for mathematics.

Norazrena and Khairul (2011) developed computer-based software for teaching and learning the topic of fractions. The software was developed based on the ADDIE model, which stands for Analysis, Design, Develop, Implement, and Evaluation. This study was conducted in a secondary school for students with special needs. The content of the software is based on the basic concepts of fractions, which include proper fractions, and addition and subtraction of fractions. In addition, the software developed for the study focused on special needs students in Form 1.

Hanim and Hairulniza (2002) also created mathematical software based on the ASSURE model for fractions in the Form 1 syllabus. The ASSURE model involves six stages of development, which are Analysis, State objectives, select method, materials and media, Utilise the materials, Require learners' response, and Evaluation.

This software acted as a medium for tutorials in fractions, including all operations in fractions such as multiplication, division, addition and subtraction. It gave spontaneous feedback on students' exercises and made the learning process more interactive (Hanim & Hairulniza, 2002). Tests were also prepared for all subtopics to improve students' knowledge about the topics. Participants enjoyed the learning process using this software. It also enhanced students' behaviour and critical thinking regarding this topic.

In addition, Neurath and Stephens (2006) used Microsoft Excel as a teaching aid for algebra class. They conducted a study in a secondary school through experimental research. Traditional methods of teaching were delivered to a control group, while the experimental group was taken to a computer laboratory and were shown various problems and how to solve them using Microsoft Excel. Three comprehensive tests were given to both the control group and the experimental group, involving the same questions. They found a slight increase in students' achievements and in their interest in the topic among the experimental group. They enjoyed the Excel assignments and increased their overall understanding of algebra, which blended well with computers and technology.

Meanwhile, Stephen and Konvalina (2006) conducted another study on the effectiveness of the MAPLE program in algebra. They also conducted research in a secondary school. This study found that MAPLE increased the positive attitude of students with regard to algebra. Stephen

and Konvalina also conclude that the MAPLE program increased students' achievements by 5% when MAPLE was used to complete algebra assignments.

Furthermore, it was shown that for students who chose to complete their assignments using MAPLE, their achievements on their final exams were improved.

In summary, past research has been done on the integration of ICT into mathematics teaching, for example using Microsoft Excel, computer-based software and the MAPLE program. Nevertheless, the extent to which the

application of these forms of technology is proven to enhance mathematics learning amongst students and the constraints faced need to be further explored. This paper, hence, has two objectives: To explore the benefits of integrating ICT into teaching and learning mathematics at secondary school levels, and to identify the barriers faced integrating ICT into teaching and learning mathematics.

The Needs for ICT in Mathematics Education

ICT is an instrument for effective teaching and learning of all school subjects. Technology in general and ICT in particular is an aid to teaching and a tool in the facilitation of learning (Adegoke and Owolabi, 2007).

User of ICT such as Davis (1997) reported that students can work independently; information is made nearer to the learners thus breaking the barrier of information distance negative attitude of any teacher will have be minimal effect on learners.

According to Olorundare (2011), ICT has the following potentials in the implementation of the school curriculum;

1. It accelerates and deepens student's basic skill in any school subject especially reading mathematics and the sciences
2. It challenges students to learn, be independent and hence be responsible
3. Helps to update students' academic knowledge and teacher's instructional practices
4. Teachers are provided with efficient and effective tools to take care of students individual differences

5. Opportunities for close cooperation with colleges in the same networking and internet services
6. Educators are challenged to new method of acquiring knowledge through

The Benefits of Applying ICT to Learning and Teaching Mathematics

Based on the literature review, one of the benefits of applying ICT in the teaching of mathematics is creating interaction among students (Keong *et al.*, 2005; Neurath & Stephens, 2006). The use of technological devices such as graphing calculators encourages interaction among students to share their knowledge and skills. The findings from two studies indicate that cooperation among students occurred when they were given the opportunity to present their work with the aid of a projector, a screen and a laser pen. Students shared their work with classmates in discussion sessions with the help of teachers (Condie & Munro, 2007; Keong *et al.*, 2005). Indirectly, the communication that occurred among students through the application of technology during the learning process promoted knowledge and information-sharing. Educators acted as facilitators, while the learning process that occurred with the help of technology as a learning tool was student-centred (Condie & Munro, 2007; Keong *et al.*, 2005). This supports constructivist learning, which is the construction of students' knowledge. The application of technologies such as the internet further facilitates students' self-exploration, for example using the internet to understand mathematical concepts learned (Keong *et al.*, 2005; Ramli *et al.*, 2006). The application of information technology can also increase students' motivation and interest towards mathematics. This was evident when students' results in algebra improved (Keong *et al.*, 2005; Neurath & Stephens, 2006). The use of Microsoft Excel in learning algebra can change students' perceptions of algebra. Students are eager to perform tasks with the aid of Excel, and indirectly the learning process becomes meaningful to students.

The same study found that students admitted to having an increased understanding of algebra with the help of computers. The same was found with regard to the usage of computer software for fractions, as examined in two of the selected studies (Hanim & Hairulniza, 2002; Norazrena & KhairulAnuar, 2011). The computer software developed greatly assisted students in improving their understanding of fractions. The exercises provided by the software gave students direct feedback. Hence, students were able to identify their mistakes and make

corrections (Ghavifekr *et al.*, 2012). In addition, the menu quiz developed within the computer software helped students to hone their critical thinking. This is because the quiz provided had a limited response time. The time limit was set to test students' critical thinking and their understanding of the fractions topics learned.

Three other studies showed that the application of ICT in learning not only generates higher-level thinking skills among students, but also encourages students to think about strategies in solving mathematics problems (Condie & Munro, 2007; Keong *et al.*, 2005). In addition to giving students prompt responses, the computer software developed encouraged students to do exercises repeatedly until the correct answers were obtained. Indirectly, this approach increases students' interest and motivation to keep trying.

Becta (2013) summarised the key benefits ICT promotes greater collaboration among the students and encourages communication and the sharing of knowledge. ICT gives rapid and accurate feedbacks to student and this contributes towards positive motivation. It also allows them to focus on strategies and interpretations of answers rather than spend time on tedious computational calculations. ICT supports constructivist pedagogy, wherein students use technology to explore and reach an understanding of mathematical concepts.

Constraints Faced by Educators in Integrating ICT into the Teaching of Mathematics

Despite the advantages resulting from the integration of ICT into learning processes in mathematics, some constraints are faced by educators in the implementation of ICT. Among the constraints faced by educators are reduced teaching time in the classroom, insufficient training on the application of ICT, weak technical support, limited resources for students when at home, and limited pedagogical knowledge on how to integrate ICT into teaching (Afolake & Shittu, 2005; Keong *et al.*, 2005).

The limited time for teaching mathematics in the classroom has become the main limiting factor for educators when integrating ICT into their teaching (Keong *et al.*, 2005). These time limitations include the need to prepare the equipment before starting the learning process. This could include computer equipment, screens, projectors and others, which take time to set up, as educators are unused to handling these tools (Rohani, 2011). In case of damage or minor difficulties, educators require assistance from technicians, which further interferes with their

teaching time. 40.8% of teachers stated that they had received insufficient training on the application of ICT to ease teaching the mathematics curriculum. The training required includes methods of integrating ICT into teaching mathematics. Furthermore, 59.5% of teachers admitted that several types of training on ICT applications were needed, in order for them to identify the appropriate applications for the teaching and learning of mathematics (Abramovich, 2014; Afolake & Shittu, 2005). Training should be conducted periodically and should meet the need of mathematics educators so that it is useful in practice.

A lack of technical support for the integration of ICT into the teaching of mathematics is also a limiting factor for educators. Problems in technical support include the provision of limited computers for students, damaged equipment which take a very long time to be repaired, booking procedures for computer labs, and educators' limited computer skills. However, the technical support factor strongly influenced the frequency of educators integrating ICT into their teaching.

Another factor that becomes an obstacle in the implementation of ICT in the teaching of mathematics is limited technological resources when teachers or students are at home. 78.4% of educators admitted that their students do not have good access to the necessary technology to facilitate learning at home. For students who do not have computers and internet access, learning through ICT applications will be limited to school only (Keong *et al.*, 2005; Ruthven *et al.*, 2009). Similarly, educators who do not have access to the necessary technology will be impeded in their preparation of teaching materials for mathematics.

In addition to the factors listed above, there are also minor constraints that hinder teachers from applying ICT in their teaching of mathematics. Among these are insufficient computer software, ICT integration not being a priority for the school, and difficulties in attending training on ICT skills (Afolake & Shittu, 2005; Palmer, 2003).

Methodology

This research deployed a survey method to investigate the use of ICT and the barriers of integrating ICT into the teaching of mathematics. A questionnaire was adopted to sample mathematics teachers from twenty selected secondary schools in [Ilorin west local government of Kwara state. The questionnaire was divided into six areas; (1) the teacher profile (ii) how

teacher use ICT (iii) professional development activities (IV) the teachers' ICT experience (v) the level of use ICT (VI) the barriers faced by teacher.

Results and Discussions

The table 1 below shows the ICT applications in general by mathematics teachers. Common ICT applications by teachers

Application	Daily %	Weekly %	Monthly%	Two or four times a year	Never %	NA%	NR%
Computers in general	16.2	21.4	20.2	12.7	3.2	8.9	17.4
Word processing packages	18.9	23.5	21.9	17.6	4.1	9.8	4.2
Database	2.8	5.6	14.2	28.9	33.4	10.0	5.1
Graphical	1.6	6.8	12.8	20.8	36.2	14.7	7.1
Search engines for internet	13.5	16.2	19.4	23.4	18.9	2.1	6.5

Table 1 above shows the percentage of using by teachers in the various ICT applications: 70.5% of the respondents used computers on a regular basis word processing packages (81.9%), data base (51.5%), graphical applications (42%), search engine for internet (72.5%).

Table 2: Uses of ICT in the class

Application	Using presentation tools	Using course ware	Online demonstratio n	Using graphical presentation tools	Others	None
Response(%)	22.5	24.8	6.1	7.2	3.2	36.2

The table 2 above shows the percentage distribution of ICT uses in the class 22.5% used ICT as presentation tools, 36.2% did not use ICT in the classroom. 6.1% use online demonstration, 7.2% use graphical presentation.

Table 3: Uses of Internet by Mathematics Teachers

The internet was used for various purposes 29.2% respondents used it for browsing, 18.8%

Activist	Browsing	Email	Discussion forums	Chat rooms	Others	None
Response(%)	29.2	18.8	7.7	26.2	1.8	16.3

used the email facility. 7.7% used for discussion forums, 26.2% used it for chat rooms, 1.8% for other purposes and 16.3% did not use the internet.

Table 4: ICT training needs

The table 4 shows that 39.6% of the respondents require training on how to integrate ICT into

ICT training needs	Integrate ICT into teaching	Combination of needs
Response(%)	39.6	60.4

their mathematics teaching while 60.4% of them stated that they needed a combination of various types of training.

Level of ICT use in instructional programmes

The level of use of ICT in instruction was still low with 39.6% respondents stating they had not used ICT at all and 32.1% of them stating that they used ICT infrequently. On the other hand, 22.6% of them responded that they had integrated ICT into specific areas of instructional units and 5.7% stated that they had fully integrated it into their instructional programmes. Table 5 depicts the levels of ICT use in teaching below

Table 5: Levels of Use in ICT

	Frequency	percentage
ICT is fully integrated into my instructional programme	6	5.7
I have integrated ICT into specific instructional units	24	22.6
I use ICT in frequently with students	34	32.1
I have not used ICT at all	42	39.6

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Barriers Faced by Teachers during Integration

The six major barriers identified were lack of time in the school schedule for projects involving ICT (55.6%), inadequate teacher training opportunities for ICT projects (41.87%), lack of adequate technical support for ICT projects (39.4%), lack of knowledge about ways to integrate ICT to enhance the curriculum (38.8%), integrating and using different ICT tools in a single lesson (36.8%)

and the absence of access to the necessary technology at the homes of students (33.0%). Table 6 shows the percentage responses on the various barriers.

Table 6: Barriers Faced by Teachers

Barriers	% Response as		
	Not a barrier	minor	Major
Not enough or limited access to computer hardware	31.3	49.5	19.2
Availability of computer software	22.7	55.7	21.6
Lack of time in school schedule for projects involving ICT	8.2	36.1	55.6*
Lack of adequate technical support for ICT projects	14.4	46.2	39.4*
Not enough teacher training opportunities for ICT projects	17.4	40.9	41.7*
Lack of knowledge about ways to integrate ICT to enhance curriculum	10.2	51.0	38.8*
ICT integration is not a school priority	30.9	51.1	18.1
Difficult finding substitutes in order for teachers to attend training	17.7	64.6	17.7

Students do not have access to the necessary technology at home	21.6	45.4	33.0*
Teachers do not have access to the necessary technology at home	23.7	58.8	17.5
Integrating and using different ICT tools in a single lesson	15.8	47.4	36.8*

* major barrier

	% 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 mathematics	72.0	27.0	1.0	0.0

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, wherein a collection of resources and a lesson planner are incorporated to relieve the teacher from routine tasks. 72.0% of the respondents considered it to be very useful and helpful and 27.0% viewed it as useful and helpful. Only 1.0% of the respondents considered that the portal would not be very useful and helpful. Table 7 gives the percentages of the responses.

Table7: Perceptions towards the proposed solution

From the survey the following findings were found

1. The five most popular application packages used by mathematics teachers were word processing packages, spread sheet and search engines. Mathematics teachers need more time to learn to use programme like Java applets, flash presentations, graphical applications and simulation programmes which have great potential for the teaching of mathematics because they encouraged explorations and higher order thinking.
2. Courseware and presentation tools were used widely for teaching mathematics. Graphical visualisation tools and on-line demonstrations have educational value as well. More than half of the respondents did not receive any professional training in ICT. A large proportion did not have any training on how to integrate ICT into mathematics teaching. Mathematics teachers should be trained on how to integrate ICT into their mathematics teaching.
3. 71.7% of the respondents said that they use ICT infrequently or had not used ICT at all in the class. This is in keeping with the finding in the preliminary study that teachers in particular school used the LCD projector for only 29 hours over the duration of two years. School enhance teaching and learning.
4. Some major barriers hindering the implementation of ICT in mathematics teaching were found to be the lack of time in school schedules for projects involving ICT, the lack of adequate technical support for ICT projects, inadequate teacher training opportunities for ICT projects, the lack of knowledge about ways to integrate ICT to enhance the curriculum and to integrate and use different ICT tools in a single lesson.

Conclusion

The use of ICT in teaching mathematics can make the teaching process more effective as well as enhance the student's capabilities in understanding basic concepts. However, several barriers have been faced by mathematics educators in involving ICT in the teaching process. The barriers identified include lack of knowledge about technology. Minimal training and learning opportunities around ICT, and limited technical support

Recommendations

1. There should be an increase in the amount of training available for mathematics teachers concerning the use of computers and the application of ICT for teaching purposes

2. Technical support is also needed in order to motivate teachers to implement ICT in their teachings
3. Educators should also determine the appropriate technologies and applications that can be integrates into the mathematics teaching and learning process.
4. It is also recommended that the contents of the subject be reduced so as to integrate ICT
5. More period of time should be allocated for mathematics lesson in order to integrate ICT in teaching and learning mathematics effectiveness.

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