



MATHEMATICS: A CASE STUDY

Monalisa Dash

Lecturer in Education, Brajrajnagar College, Sambalpur University, Odisha

Abstract

Information and Communication Technology (ICT) into education is recognized as providing opportunities for developing skills for 21st century, having the potential to transform pedagogical practices and playing a role in reforming curricula. Additionally it is considered an essential tool for developing higher order thinking skills in students by providing a grave clarity in understanding of the concepts. ICT also plays a key role in constructivist approach of teaching. In spite of such mammoth of benefits provided by it, ICT is still struggling to get into the blood of education. The massive challenge faced by teachers here is the best ways to integrate the ICT in their subjects for a fruitful result. To enable the mathematics teachers to become well equipped with effective ICT integration skills into their teaching and learning practices, a case study of four mathematics teachers (recipients of National ICT awards for school teachers) was conducted. The evidence for the study was collected by qualitative interviews of individual teachers. This paper describes the innovative approach adopted by the teachers for enhancement of students learning. It focuses on strategies implemented for use of ICT in teaching-learning. It highlights the educational issues addressed, integration of ICT tools, e-resources and students involvement in ICT integration. It also illuminates the path of professional development by the use of ICT. It describes the help of ICT to improve as a teacher. This paper narrates the impact of ICT on students learning and various assessments strategies adopted to measure their learning. It emphasizes that designing learning according to real-life events or situations helps learners to internalize learning by engaging in critical reflection and cooperation. The best part of the paper is that it emphasizes on integrating technology skills at appropriate times based on authentic learning situations from actual school life. Suggestions are provided so instructors can select the appropriate information and communication technology tools to maximize teaching effectiveness.

Keywords: ICT integration, mathematics teachers, National ICT awards for school teachers, qualitative interviews



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“Technology can greatly aid the process of mathematical exploration, and clever use of such aids can help engage students” (National Council of Educational Research and Training, 2006, p.11).

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When we talk of ICTs, we refer not only to the latest computer and Internet based technologies, but also to simple audio visual aids such as the transparency and slides, tape and cassette recorders and radio; video cassettes and television; and film. United Nations Development Programme (UNDP) defines ICTs as “the information-handling tools that are used to produce, store, process, distribute and exchange information. They include the ‘old’ ICTs such as radio, television and telephone, and the ‘new’ ICTs like computers, satellite and wireless technology and the Internet.” These different tools work together to form an interconnected world which reaches into every corner of the globe.

With the integration of Information and Communications Technologies (ICT) teachers are enabled to increase students’ engagement in the classroom that in turn enhances their learning and encourages them to become life-long. In order to improve the learning outcomes of the students, the teachers should integrate ICT in their teaching practice (McGehee & Griffith, 2004) yet, this could not be realised (Brooker, 2003). ICT integration can be proved to be successful only and only when the teachers use it effectively in their classroom which in turn requires proper training of teachers in using ICT tools so as to implement it efficiently in the real classroom situation.

Increasingly, researchers are making efforts for the adoption of some strategies where ICT can be integrated successfully in the teaching and learning processes. Reynolds (2001) suggests schools are presently using ICT just to access information to supplement their lessons instead of making it an integral part of their pedagogical practice. Moreover the actual potential of ICT can then be exploited only when it is used to enhance the higher order thinking skills of students. This study explores the intricacies of the ways in which the school teachers successfully integrated ICT into their Mathematics classrooms to enhance students’ achievement.

The Context of the Study

The teachers involved in this study are the awardees of “National ICT Awards for School Teachers” who have done a commendable job in successfully integrating ICT into their respective classes and made a significant improvement in teaching- learning process thereby bringing remarkable outputs some of which are better learning outcomes and catering to individual needs of students. These teachers have actually honed their skills pertaining to successful integration of ICT and put in massive efforts for its implementation. In this study the teachers share their experiences about ICT integration

in mathematics. This report uses examples of learning activities and teaching practices from the teacher interviews contributed by the participants.

The Research Approach

Stake's (1995) case study played a significant role in this study as an inquiry strategy. This study makes an effort to provide an insight of best utilization of ICT tools in a real classroom situation by identifying the ingredients of successful ICT integration. This study not only highlights the possibilities and methods used for better ICT integration but it also enumerates the factors influencing this practice.

Participants. In this case study four Mathematics teachers from various places of India who have won the "National ICT Awards for School Teachers" have participated.

Instruments. The evidence for the study was collected by a semi-structured interview schedule prepared by the researcher.

Results

The result of the study is analyzed and differentiated into different themes for better understanding of interview responses. The 4 mathematics teachers were interviewed via telephone for around 45-60 minutes each. A semi-structured telephonic interview was adopted in this case for convenience and as agreed upon by both the researcher and the teachers. Then the interviews were recorded, transcribed, coded and segregated into themes. The transcriptions were cross checked by the teachers before analysis so as to confirm its correctness. This study presents the results obtained from the interviews of the teachers in form of different sections. Evidences have been collected from the teachers' portfolios to cite examples from it for better understanding of the ways of actual ICT integration in a classroom.

Section 1: Important factors to consider before planning for ICT integration in classrooms. The teachers highlighted two important factors namely time and access to be considered before planning for ICT integration in classrooms. First, time was a constraint for all teachers to implement ICT in their classrooms. Participant B pointed out that due to his professional commitments and increased work load he was not able to concentrate and invest time in developing ICT integrated lessons and learning materials to large extent which he otherwise wanted to do for better usage of ICT in the classrooms. Participants A, C, and D found that the creation of good standard ICT teaching resources to enhance students' learning experience in the classroom required them to work for long hours even at home.

Secondly, three teachers remarked access as another constraint in the way to successful ICT integration. The ill infrastructure of the school comprising of inappropriate school structures was pointed out to be a main constraint by the teachers. Moreover the timetable constraints, the acute shortage of computers and computer labs, the heavy syllabus and its timely completion provided hindrance both in time and access. All the four teachers expressed disappointment over the aforementioned hindrances in the path of better ICT exposure to students and affirmed that the situations needed to be reversed.

Section 2: Planning and Preparation for integration of ICT into the Mathematics curriculum. All four teachers relied heavily on the Internet to provide both resources and inspiration for their use of ICT in units of work. They used the Internet for researching a topic, collecting resources and providing relevant information for students. Participant D specifically researched, explored and gathered several mathematical simulations and interactive activities from the websites. He also noted numerous examples from the internet and provided them to the students to expand their understanding on mathematical concepts. Participant A stated, “One can go to the website ictcurriculum.gov.in and do a free course there.....And once certified by MHRD or NCERT can start any course in the country.” All four teachers had produced numerous online resources and courses using Geogebra and Edmodo. These teachers mainly used mathematics worksheets and games in large amount from the internet with primary motive of reinforcement of mathematical skills and enhancement in comprehension of mathematical concepts. “My strategy for the use of ICT in the classroom is three-fold. I focus primarily on helping students see and experience mathematical concepts in exciting ways, use new methods to practice and test new material, and stay in touch with students and parents outside school hours.”

Section 3: Preparation of lessons to teach via ICT. Different teachers planned their lessons in various different ways. Participant D worked with other teachers collectively and planned the trans-disciplinary units. This helped him to determine different topics from mathematics lessons, the concepts to be taught and the different software or other ICT tools to be used for those lessons. In planning Trans-disciplinary Units, Participant D described working with other teachers to determine what topics, content, and technology tools should be utilised. Participant A explained the ‘Area and Volume’ unit, given as an example. Here students were encouraged to visualize the transformation of shapes from 1D to 2D to 3D by paper folding

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in Origami then they developed an intuitive sense of geometry by using tangram. Lastly they practised the learnt concepts on GeoGebra. Children learnt how to produce the desired shapes like greeting cards, ice-cream cones, boxes, cartons, gift wrappers etc. Each unit outlined details of the outcome gained through the ICT integration particularly the associated mathematical skills and concepts.

ction 4: Teaching practices. The teachers agreed that usage of ICT made their classrooms student centered, making it quite vibrant and engaging and provided motivation to students to a great extent. Moreover, these teacher themselves enjoyed integrating ICT in their classrooms that in turn enhanced their professional practice. They also believed that the students were filled with gratitude for introducing ICT in their classrooms and expected the same, more and more in each class. Participant B stated that usage of ICT in his classroom offered some great opportunities to explore various teaching methods and brought improvements in his teaching practice that helped him to evolve as a teacher. Participant C said “ With technology by my side I am a stronger, more effective teacher who is connected with her students 24 x 7. My lessons have become richer in content; the explorations and visualizations possible with GeoGebra, Desmos and other Web2.0 tools have made mathematics come alive.” “ I have established myself as an effective and inspiring leader as I model self- learning and innovation for my department and other staff members of my school and hundreds of other teachers whom I have trained or interacted with.” Participant D did, however, focused on lower level thinking skills activities in Mathematics by using ICT but he was planning to elevate the focus to higher level thinking skills to assist his students’ deep learning in his forthcoming classes and he believed that such an act would definitely improve his teaching practice. Participant B said an important thing “Teachers should not use ICT just because they wanted to use it. One should know which ICT tools should be used where and why in the content...for example using powerpoint restricts a child to obtain the information that is just displayed... but using GeoGebra helps him explore the content in detail and also provides hands-on practice that is essential for learning.”

Section 5: Advantages of integrating ICT in classroom. All the teachers in this study said that the ICT integrated classroom enhanced the higher order thinking skills of the students like analytical skills, problem solving skills and critical thinking skills. Participant B described that ICT integration in his classroom helped in better digestion, assimilation and positive transfer of information and it also immensely supported the individualized form of

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learning. In his classroom he demonstrated and encouraged the students to use MS Excel for entering data and its transformation into graphical forms and MS Power Point for the presentation of their own work. He further added that self-assessment in ICT integrated teaching boosts up the confidence level of children. All the teachers agreed that the ICT integrated classroom provided a motivating and stimulating environment for the students. The teachers furnished general details on the benefits of ICT integration in their classroom rather than some specific ones.

Section 6: Introducing a new computer application. All teachers suggested from their experience that in order to introduce new computer application they first modeled it in front of the whole class, then they divided the students into small groups and encouraged them for working with those applications. The teacher then facilitated those students encountering some problems and at the same time motivated them consistently so as to learn the application without any fear. In most cases, computer softwares like GeoGebra and Tangram were used in ICT integrated mathematics classes. The students who had mastered these skills would act like peer tutors and assist their classmates in acquiring the newly learnt skills. During such a scene, Participant B would take up the role of a mentor. Participant D gave an example of lesson where he taught the usage of a graphical calculator. In that case he would first demonstrate the use of graphical calculator for around ten minutes in front of the class with few examples. Then the students would themselves work with the computer applications and explore its usage.

Section 7: Confidence. The consistent usage of ICT in their classrooms had built up tremendous amount of confidence in the teaching practices in all the teachers of the study. All the teachers were able to develop various resources in mathematics that boosted their confidence level. The proof here is their participation in more engaging tasks of preparing e-content modules in mathematics and training other teachers about the software used. ICT integration in their teaching not only helped them to teach new computer applications to the students but also enabled them to create an engaging environment where the students were able to exchange their ideas and work collaboratively. This led to an increase in improved learning outcomes that made the ICT integration in their classrooms all the more compelling.

Section 8: Objectives for Using ICT with Your Students. All the teachers agreed commonly that the usage of ICT resources and applications helped the students master the ICT skills. It

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encouraged them to work independently and search for information regarding their concepts and doubts. This leads to make mathematics meaningful. Additionally, Participant D described that his students gained a double benefit by learning ICT skills and understanding the mathematical concepts simultaneously. Participant B used ICT to make children learn mathematics easily. He also said integrating ICT in mathematics by using software not only made his children learn mathematics efficiently but also improved their digital literacy.

Section 9: Teacher Skills. All the teachers in this study believed that they developed high ICT skills like using MS Word, Excel, Power point, email, search engines, multimedia presentations and desktop publishing just by practicing integration of it in the classroom and by developing resources in mathematics for their students. Teachers found that they had low skills specifically in graphics and the applications with database management. However, they agreed that they could learn it quickly if they themselves incorporated them into their teaching programs.

The best part was exploring GeoGebra. GeoGebra is an open source, available in many international and regional languages. The software can be downloaded on any device and can be carried around on a pen - drive. GeoGebra app is also available for the Android devices. So this software is ideal for our classrooms (across India) where many schools don't have internet. The teachers and students can easily use this software. It is a demonstration and exploration tool; for classrooms with one device it can be used for demonstration whereas with multiple devices students can create with it individually or in pairs. "I use GeoGebra to demonstrate concepts which when visualized make maths meaningful." As said by Participant C. This dynamic geometric software allows students to trace Trigonometric functions, make connections with the slope of tangent and derivative of a function and much more. The middle school students love to use GeoGebra to discover geometric results, for them Pythagoras theorem is no longer limited to a Right angled triangle and Squares but extended to Regular polygons and Semi-circles; an exploration way beyond the limitations of textbook and paper-pencil constructions.

Section 10: Professional Development. ICT has opened a world of opportunities for these teachers; both as a learner and as a teacher. By actively using various technologies in the classroom and sharing it in teachers' community have made them achieve

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numerous recognition like national ICT awardees, Google certified trainer, Edmodo Certified Trainer. The teachers have been invited from NCERT time to time for various training programs. They have also contributed to NROER, youtube videos, ICT curriculum development etc. Participant B said “Using ICT has helped me in my administrative work as a Principal of the college”. All agree that they have evolved and strengthened their abilities as teachers. They feel empowered, energized and enthused to teach.

Section 11: Suggestions for the teachers. “ICT integration should not be done just for integration purpose.” said Participant B. “It should be done as and when required to make the learning easy.” While Participant A commented “If we can use android phones then we can certainly use computers because windows is less sophisticated than android technology, what we need to erase is technology phobia....perhaps digital sensitisation of society is required.”

Discussion and Implications

We can conclude from the interviews of the teachers in this study that they firmly believed in the potential of ICT as an educational tool that enhances students understanding of the concepts by providing them creative learning experiences. Though all the teachers exhibited differences in the usage of ICT, they all developed their ability to create mathematical resources in mathematics and even communicated about these resources with other professionals via email. The teachers also designed many ICT opportunities for students that enhanced their learning for instance online quiz, Learning management system, interactive games, web quests and digital simulations. It appeared that they identified the usage of specific computer applications for the enrichment of student learning by creating resources to support the integration of ICT in their classrooms.

According to Shulman (1987), very limited evidence were gathered concerning learners’ characteristics and knowledge, pedagogical content knowledge and integration of ICT for better understanding of mathematical concepts. This study suggests that the teachers had successfully discovered the connections between the content, the learner, their context and ICT as an educational tool for enhancing mathematical understanding in students. They emphasized the importance of context in ICT integration. The dedication of teachers towards the progress of students, their willingness to use ICT in this regard, their effective use of ICT skills and their firm determination to enrichment of their own professional

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development led to a development of their teaching practice.

This case study's results indicate many significant educational implications useful for the teachers and developers of professional development programs. The integration of ICT into teaching and learning of mathematics not only elevates students' learning but also enhances teachers' professional development. But ICT should be integrated where ever felt necessary and should not be integrated just for the sake of integration. Teachers can start integrating the ICT without taking even any formal training, just they need to overcome the phobia of technology. Moreover there is no need for plenty of resources, just one or two ICT tools can serve the purpose. Preparation of lessons, assessment of students and students' feedback are successful ingredients of successful ICT integration.

According to McGehee and Griffith (2004) teachers should use technology to promote the mathematical thinking skills and enhance the understanding of mathematical concepts. Thus we can say that more professional development programs regarding ICT integration should be developed so that teachers can learn the ICT applications and its appropriate usage in their classes to promote mathematical understanding. One of the teachers in the study also suggested that examples of the ICT integrated lessons and student work may definitely prove helpful in a better understanding of the impact of ICT on students' learning outcomes.

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