EFFECTIVENESS OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) IN TEACHING MATHEMATICS AT SECONDARY LEVEL

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ABSTRACT

The purpose of this study was to determine the effectiveness of Information and Communication Technology (ICT) as compared to the traditional method of teaching in the subject of mathematics at secondary level in Pakistan. It was an experimental study and post-test equivalent group design was used for the statistical analysis of the research at 0.05 levels of significance. As the target population were the secondary school students, a sample of one hundred and twenty students was selected in such a way that sixty students were available for each cluster of Public and Private sectors. Students of sample schools were divided into two equal groups, i.e. experimental group and control group, each having thirty students. Both the groups were equated on the basis of their scores by pair random sampling from the previous examination of class VIII in the subject of mathematics. The students of experimental group were exposed to the teaching through ICT, where as the students of control groups were taught through traditional method of teaching in the subject of mathematics. The units taught to both the groups were Sets, Algebraic Expressions, and Logarithm, chosen from the prescribed syllabi for class IX by Federal Board of Intermediate and Secondary Education. ICT was found effective as compared to traditional method of teaching in mathematics at secondary level for private sector school.

Key words: ICT, Mathematics, traditional method of teaching, private sector, public sector, secondary schools.

1. INTRODUCTION

The aim of teaching-learning process is to enable the students to earn livelihoods for them as well as to become useful member of society. In primitive societies, this adjustment meant conformity with the things as they were. The success of this process depends on the degree of interaction and communication between the teachers and learners (Woolfolk, 2004). The teaching and learning are closely interlinked and each learner has the right to choose his own path instead of being made to fit in the stereo typed education system, which demands individual attention, initiative and self-education among the learners. Modern approaches encourage the learners to work independently, free to set their own goals, plan their activities and share their opinions with teachers freely. Teachers act as guide and counselor in the modern school of thought (Kochar, 1992).

The use of ICT has brought tremendous progress in the field of education in developed and developing countries and it has also brought revolution in teaching-learning process by changing the roles of teachers and learners. In developed countries ICT is being used successfully, but in developing countries, like Pakistan, its use is limited due to the cost and scarce resources. Information Communication Technology (ICT) is the major factor in shaping the new global economy and producing rapid changes in society. Its scope and coverage is unprecedented in human civilization due to the access to information, communication, knowledge and entertainment. The new ICT tools have changed the ways the people used to communicate resulting in significant transformation in industry, agriculture, medicine, business, engineering, and other fields. ICT has the potential to transform the nature of education, teaching methods, and the role of students and teachers in the learning process. The new technologies challenge the conventional concept of both teaching and learning methods, and materials and by re-configuring how teachers and learners access knowledge. To meet this challenge schools must embrace the ICT tools for teaching and learning to move towards transforming the traditional paradigm of teaching (Williams, Sawayer and Hutchson, 1997).

Educational technology has made high progress in the last few decades. In Pakistan implementation of ICT in schools is at its initial stages. Teachers need to enhance their basic knowledge and skills in ICT as well. To enhance the use of computers in schools and to achieve the required educational goals, computers can be installed in individual classrooms, in central computer labs, libraries, and teachers planning room, or moved from room to room on mobile carts, depending on the requirements and resources available in the schools (Pandey, 2001). Technology includes not only tools and machines, but also their impact on processes and systems, on society, and on the way people think, perceive and define their world. Over the past few decades, a particular dimension of technology has come to permeate nearly all aspects of human life. The information technologies, comprising computers and their peripherals, computer software, the Internet and electronic multimedia, are becoming part of our daily existence at an ever-increasing rate. This reality also forms the need to integrate information technology into curricula for the various subjects (Mishra, 2005). Since there are changes in the views of the nature of science and the role of science education, the increasing prevalence of Information and

Communication Technologies also offers a challenge to the teaching and learning of science and to the models of scientific practice teachers and learners might encounter. ICT for example, offer a range of different tools for use in school science activity, including;

i. Tools for data capture, processing and interpretation-data logging systems, databases and spreadsheets, graphing tools and modeling environments.
ii. Multimedia software for simulation of processing and carrying out virtual experiments.
iii. Information systems.
iv. Publishing and presentations tools.
v. Digital recording equipment.
vi. Computer projection technology.
vii. Computer controlled microscope.

These forms of ICT can enhance both practical and theoretical aspects of science teaching and learning. Although computer literacy and awareness are increasing, but still, the quality of professional competence and skills in this area are still lacking. Teachers have also found computers extremely valuable as an aid to valuable demonstration, for use in the classroom situation, as it is possible to prepare still and animated demonstrations. These uses are, however, examples of how a new technology is often at first treated in a traditional way. The excitement and the challenge of the computer and the methods of IT are such that they cannot be contained in the traditional ways of education. Computers are the potential extension of self, and as such cry out for "Hands-on" experiences (Hills, 2002).

One of the major roles in the adoption and implementation of ICT in education is performed by the teachers, since they are the integral part of teaching and learning process. For example, teacher's lack of ICT knowledge and skills to be a major obstacle to the implementation, and consequently pointed to the need for further training of teachers in this field. If education is to provide an adequate preparation for the future, schools must empower learners to become more active and more responsible for arranging their own learning process (Palgrum and Nancy, 2003).

The subject 'Mathematics' is the numerical and calculation part of man's life and knowledge. It helps man to give exact interpretation to his ideas and conclusions. It deals with quantitative facts and relationships as well as with problems involving space and form. It also deals with relationship between magnitudes. Mathematics studies order abstracted from the particular objects and phenomena, which exhibit it, and in a generalized form (Saleem & Khalid, 2000). The more the technology is developed the greater the level of mathematical skill is required. Research indicates that teachers who have a good background in Mathematics also add richness to their lessons, involve students' extensively in mathematical dialogue and capitalize on student's questions / discussions to weave/ extend mathematical relationships.

The world is rapidly transforming itself into a global village, so to face its challenges; the country needs to nurture a computer culture. The importance and need of IT is accepted universally as a pre-requisite and norm for progress and development. The Government of Pakistan has shown its commitment at the highest level of hierarchy to introduce IT in all its operations and in the country.

The potential of Information Technology was considered, as the vision of the National Policy (2001-2002) and as a key contributor to the development of Pakistan.

Stuve (1999) explored that learning was affected by certain features of the classroom environment, like the location of the printer in relation to the class and the quality of the computers, as well as how projects were structured and how learning activities were maintained. His argument was that the implementation of technological innovation is socially constructed, with a complex interaction among students, teachers, and the physical and local environments. Norton & Debra (2001) studied beliefs about using computers for Mathematics learning and found that: (i) few secondary Mathematics teachers used computers at least weekly; (ii) computers were considered equally or more effective than traditional instruction for doing calculations or providing basic skills practice; few teachers considered computers useful in developing conceptual understanding (iii) no teacher used computers with less able senior mathematics students. Norton (1999) noted that computer coordinators claimed that mathematics teachers under-used available computer resources claiming difficulty of access. The coordinators considered this an excuse for teacher's lack of knowledge about suitable software, concerns about the changing role of teachers, lack of time to plan computer-based mathematics learning, worries about not covering the syllabus, and fear of computers.

2. OBJECTIVES OF THE STUDY

Following were the objectives of the study:

- To determine the effectiveness of Information and Communication Technology (ICT) on the academic achievement of students in mathematics at secondary level as compared to the traditional method of teaching.
- To examine the effectiveness of ICT in contrast to traditional method on academic achievements of students in mathematics in public and private sectors at secondary level.

3. METHODOLOGY

The study aimed at investigating the comparative effects of the use of Information and Communication Technology (ICT) with the traditional method of teaching in mathematics at secondary level. The dependent variable in the study was the achievement in the academic scores of the students, whereas the independent variable was the teaching strategy.

3.1. Population

The study was conducted to see the effectiveness of ICT in the subject of mathematics at secondary level as compared to the traditional method of teaching. Thirty nine thousand, seven hundred and sixty (39760) students in six hundred and thirty seven (637) institutions affiliated with Federal Board of Intermediate and Secondary Education, Islamabad (Result Gazette, 2008), studying mathematics in class IX comprised the population of the study.

3.2. Sample

A sample consisted of one hundred and twenty students studying mathematics in class IX at two selected public and private sectors. The selected schools have the same syllabi of Mathematics at secondary level and had computer lab facilities. Students of every sample school were divided into two groups, experimental group and control group. Both the groups were equated at their scores in the final examination of class VIII in the subject of mathematics. The students of experimental group were exposed to teaching through ICT, where as the students of control groups were taught through traditional method of teaching.

3.3. Research Instrument

In order to measure academic achievements of the sample students in the subject of mathematics a teacher made post-test was administered immediately after completing the experiment/teaching to both the groups, in all the schools at the same time and data collected was the scores of students achieved in the post- test. The Researchers made a thorough study of three math units (Sets, Algebraic Expressions, and Logarithm) taught and techniques of test construction. Test was prepared by the researchers with the consultation of experienced math teachers at secondary level, from the topics taught to both the groups by making the chart of specification, and by considering the technique of paper setting for different understandings, i.e. 15% for difficulty, 75% for average, and15% for easy levels. The test contained 50 items as a whole, including multiple choices, true / false, match the columns, fill in the blanks, short questions-answers and problem solving. Time duration for the test was fixed as one and a half hour, which was considered appropriate for the completion of the test for both the groups.

3.4. Reliability of Test

The reliability of the post-test scores obtained by the sample students was tested by using split-half (odd-even) method. Spearman-Brown Prophecy formula was applied to find out the co-efficient of reliability from the comparable value of the post-test at 0.5 levels of significance, and was found to be 0.75 which was acceptable.

3.5. Orientation of Facilitator and Students

Two Mathematics teachers of equal qualifications and experience from each sample school were selected through the permission of the respective principals of the schools. However, the teachers who had to teach the experimental group were also computer literate. In one of the sample schools, a two day meeting for the organization and orientation of the teachers was arranged. The objectives and procedure of the study were made clear to them. Two units, i.e. sets and Algebraic Expressions to be taught were explained to them. Teachers of the control groups were specifically told to teach the students by using only traditional method, and not using any kind of technology. Whereas it was explained to the teachers of experimental group how to use the technology effectively in their teaching by using computer, Internet and chatting on web. CD's and USB loaded with math software/programs were also given to them, and were told to install them in their computers. They were also advised to make and share their e-mail addresses with each other and with their respective students.

The researchers and their computer teacher gave the students of experiment groups three days orientation and hands on opportunity on use of computer before starting the experiment in their break time. Since the students were already computer literate, they were just made to familiar with the requirement of the experiment by the use of e-mail, chatting, and Internet. The e-mail addresses of all the students of these groups were made and shared between all of them including their teacher. They were also trained on composing mathematical questions, assignments, sending, replying and receiving e-mail messages of teachers, fellow students, and to get link on-line with tutors. Also during the orientation they were given the demonstration and opportunities to acquire different resources of mathematics teaching around the world.

3.6. Control Group

The materials used in the teaching of control group were mathematics text Book-IX, white-board, blue and red board markers and exercise books. Teacher gave instruction to the students through traditional method, that is, by delivering lectures from the textbook, and frequently using the white board. Also the teacher required students to solve the exercises given in the textbook in their notebooks, after solving few of them on the white board, to involve the students in drill and practice activity. Daily homework was assigned to students and checked regularly by the teacher. Control group was given guided practice and independent practice throughout the time period allocated for the experiment, to control the variable of time and to comprehend the main objective of the study.

3.7. Experimental Group

The students of experiment group received the treatment of independent variable, i.e. use of information and communication technology (ICT). This group consisted of one computer for two students, all computers connected with Internet and loaded with math software having different program related to the topics under study through the main server. For the conveniences of the students and teachers Algebra solver programs related to the

units taught were downloaded from the Internet, and the following software of the websites were also given to them,

a. Algebra Solver (Software)
b. Algebra Helper
c. Cool Math
d. SOS mathematics
e. Web Math
f. Algebraic Info Mathematics

In addition, for further drill and practice, the websites were also given to the teachers and students. Students were taught to make their e-mail addresses, and were made able to chat for sharing and solving their problems related to their study with their own teachers, other students or on-line resource persons.

4. DATA ANALYSIS

At the end of the experiment, i.e. after six weeks, post- test was administered for both the groups at sample schools. The scores achieved by the students of both the groups of sample schools were recorded separately, and were treated as academic achievements of the students for statistical analysis, to accomplish the objectives of the study.

Table 1. Significance of difference between the mean scores of students of public sector of experimental and control groups on previous examination

Group	N	Df	Mean	SD	SE_D	t-Value
Experimental	30	29	23	7	1.3	0.584*
Control	30	29	22	7		

*Not Significant Table value at 0.05=2.78

Table 1 shows that the value of t (0.584) was found lesser than the table value of t (2.78) at 0.05 levels. Therefore, that there was no significant difference between the mean scores of students of public sector of experimental and control groups on previous achievements test in mathematics. Hence, both the groups were treated statistically equal.

Table 2. Significance of difference between the mean scores of students of private sector of experimental and control groups on previous examination

Group	N	Df	Mean	SD	SE_D	t-Value
Experimental	30	29	29	4.7	0.89	0.43*
Control	30	29	28	4.7		

*Not Significant Table value at 0.05=2.78

Table 2 shows that the calculated value of t (0.43) was found lesser than the table value (2.78) at 0.5 levels. Hence, that there was no significant difference between the mean score of students of private sector of experimental and control groups on previous achievement testing mathematics. Therefore, both the groups were treated statistically equal.

Table 3. Comparison of the mean scores of students of public sector of experimental and control groups on post-test.

Group	N	Df	Mean	SD	SE_D	t-Value
Experimental	30	29	31	8.34	2.95	1.80*
Control	30	29	26	13.57		

*Not Significant Table value at 0.05=2.78

Table 3 shows that the value of t (1.80) is lesser than the table value (2.78) at α 0.05 level. Hence, the null hypothesis is accepted and concluded that ICT as a teaching strategy is not effective for the students of public sector contrast to traditional method of teaching in mathematics at secondary level. This does not supports the findings of Williams & Jonassen (1996) that students who have gone through the treatment of ICT achieved better scores in academics as compared to others without the use of technology.

Table 4. Comparison of the mean scores of students of private sector of experimental and control groups on post-test.

Group	N	Df	Mean	SD	SE_D	t-Value
Experimental	30	28	41	5		
Control	30	28	35	6	1.24	3.30*

*Significant Table value at 0.05=2.78

Table 4 shows that the calculated value of t (3.30) is greater than the table value (2.78) at 0.05 levels. Hence, the null hypothesis is rejected and concluded that ICT as a teaching strategy is effective for the students of Private sector in contrast to traditional method of teaching in mathematics at secondary level. Which supports the findings of Johri (1998), Williams & Jonassen (1998) that students who have gone through the treatment of ICT achieved better scores in the academics as compared to others without the use of technology.

5. FINDINGS

Accepting or rejecting the significance of null hypotheses constructed for the study determined the effectiveness of information and communication technology (ICT) as compared to traditional method of teaching in mathematics at secondary level. The findings of the study were observed from the calculated values of t and F recorded in nineteen tables tabulated against the null hypotheses to achieve the objectives of the study. Following were the findings of the study;

- There was no significant difference between the mean scores of students of public sector of experimental and control groups on achievement test.
- There was no significant difference between the mean scores of students of private sector of experimental and control groups on achievement test.
- From the public sector it was found that ICT was least effective for students in the academic achievement in mathematics at secondary level. This might be due to the non-availability of the technological facilities at school or at home or due to lack of knowledge/ interest in using the technology.
- From the private sector it was concluded that ICT was effective in the academic achievements of students in mathematics at secondary level. This might be because sufficient technological facilities were available to them by their school and at homes. Students might have availed the facilities with full zeal and dedication.

6. DISCUSSION

The focus of this study was to discover effectiveness of teaching mathematics through Information and Communication Technology (ICT) as compared to traditional method of teaching in the subject of mathematics at secondary level. Significant results for the calculated value of 't' for private sector. This indicated the supremacy of the experimental group over the control group in academic achievements in mathematics. It illustrated the effectiveness ICT as a teaching strategy in mathematics at secondary level in contrast to traditional method of teaching in Private sector. These findings were supported by the findings of Johri (2000) that the group under ICT treatment scored significantly higher in the post-test, and showed that a relationship existed between the use of ICT and academic achievement of students. It is also supported by the findings of the studies of William, Sawayer and Hutchison(1997) that use of technology enhanced the students' academic achievements in education.

The calculated 't' value for Public sector was not found significant, which showed that the application of ICT in the teaching-learning process did not show any improvement in the academic achievements of students of public sector in mathematics at secondary level. It was not supported by the findings of Johari (2000) that the group under ICT treatment scored significantly higher in the post-test, and showed that a relationship existed between the use of ICT and academic achievement of students. In comparison of the results of Public and Private sectors, results of post-test on academic achievements of students of the sample schools were compared respectively with each other. So it can be concluded that students of private sector showed better performance than students of public sector. This indicated the supremacy of private sector over the other two sectors, and the students of public sectors benefited the least from the use of information and communication technology. There was no similar research observed in Pakistan.

To meet the demand of the present era, in the field of technology it is recommended to make its application more effective in education, students must be trained in IT from the grass root level. Therefore, it is recommended that Information and communication technology (ICT) must be introduced as a separate discipline in the curriculum of Pakistan from primary level. To promote ICT in education at secondary level and for students to become more familiar with the use of ICT, libraries in the educational institutions may be converted to on-line libraries. As the students from the poor families do not have the IT facilities available at their homes, so to make the use of ICT effective in the teaching-learning process the vital role of teachers in this process may be enhanced by giving them in-service training for the use of technology. For the same reason mentioned above, application of ICT might be included as an integral part of the syllabi for before- service teacher training degree program, and also at the time of induction of new teachers in any educational institution in any sector/region of Pakistan.

In the twenty first century, technology has taken its place in almost all fields of life including education. The young generation is becoming familiar with its use, since they have understood that it is the demand of the present era, but old people think that they can spend their rest of lives without using technology as they have almost spent a major portion of their lives without using technology. Therefore, special training programs of use of technology for old teachers be designed to remove their shyness for the use and understanding of ICT in the educational institutions. Computer laboratories in the educational institutions at secondary and higher secondary levels might be equipped with sufficient number of computers connected with Internet and Web. Due to lack of these facilities, students do not get sufficient time for repetition and guidance from on-line tutoring. Since repetition and guided practices is very important in mathematics at secondary level.

Application of ICT as a teaching strategy in mathematics was found effective as compared to traditional method of teaching. So to enhance its use in other disciplines of education, the Integration of ICT might be introduced in all other subjects of the curricula taught at secondary and higher secondary levels. Computer

software programs and on-line tutoring for all the disciplines taught at SSC and HSSC level might be developed locally to meet the demand of Pakistani curricula and students. Free of cost facility for on-line tutoring might be provided by the administrations of private, public and garrison sectors to slow learners for more drill and practice in mathematics and other disciplines as well. To make the use of ICT more understandable and easy for Pakistani students, software in Urdu and other provincial languages might be developed as in public sector the medium of instruction is Urdu.

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