Impact of Computer-based Instruction on Academic Achievements of Secondary Schools' students of Mathematics in District Peshawar Pakistan

Humayun Khan[*], Wazim Khan[†]

Abstract

The primary purpose of this study was to explore and approve an appropriate instructional method for teaching mathematics, utilising Computer-based instructional method in the secondary school mathematics classroom in the government schools of district Peshawar Pakistan. Purposive sampling technique was exercised. Participants of this study involved the 9th-grade 350 students. The 'Post-test only Control Group Experimental Design' was used. Computer-based instructional lessons were administered to the experimental group while the control group got the conventional method of teaching.

Independent sample t-test, was used for data analysis. CBI was concluded significantly better in comparison. Therefore, it is recommended at secondary school level in mathematics on the basis of the results of this study in the government schools of district Peshawar. However, the existing teachers must be trained through refresher courses in integrating computer technology into teaching and facilities must be provided to satisfy the students' needs and course objectives.

Keywords: computer-based Instruction, traditional method.

Introduction

In this dynamic world, where knowledge is expanding its boundaries in all directions, the skills and methods of imparting knowledge are also shifting to the new technologies and developments in education. Teacher education and pedagogy are frequently highlighted since the National Education Policy of 1969 to the succeeding polices to 2009(Khan, 2015) and onward in different Education Sector Reforms programs, workshops and seminars.

Mathematics is believed as the mother of modern sciences. Its extensive uses in our daily life has turned it significant for us to learn. Since, it is viewed as one of the key subject which provides bases for several other subjects (Wekesa, 2017), therefore, it is taught at elementary and secondary levels of education as a compulsory subject in Khyber Pakhtunkhwa (KPK) Pakistan, to boost other subject areas like Chemistry, Physics, Biology, Social Study, Computers and Arts etc.

[*]PhD Scholar Education, Qurtuba University of Science & Information Technology

[†] Professor Qurtuba University of Science & Information Technology

Mathematics is a boring, difficult (Zakaria, Chin , & Daud, 2010), discouraging, or worthless task irrespective of the grade level; consequently, it steers both the students and the teachers somewhere to frustration in the subject, similarly it is difficult to measure the quality of Mathematics teachers because teaching mathematics is a complex task (Reuben, Guimba, & Alico, 2016).

A teacher must constantly update his professional skills to compete in the present-day educational needs. The competence and skills of the mathematics teacher is the major factor in the mathematical maturity of students, that is why effective teacher should not only have mastery over content area but they must also have considerable proficiency of teaching pedagogy including a decent set of teaching strategies and activities and the insight to use a specific technique in a given situation (Brahier, 2016).At secondary level, in the KPK, students are mainly divided into two groups; the Science and the Arts. Two different versions of Mathematics textbooks are taught to them since April 2016. The science group is taught Elective Mathematics while the Arts group is taught General Mathematics. The contents of both the textbooks are different from each other. At secondary level the SSTs (Secondary School Teachers) previously known as SETs (Senior English Teachers) are responsible to teach this subject. The SST has two main categories; a). SST Science and b). SST General. The SST Science is further categorised into SST Maths-Physics and SST Bio-chemistry's Maths-Physics are responsible for teaching Science Group Elective Mathematics, while SSTs General are responsible for teaching the Arts Group General Mathematics.Most of the SSTs who were responsible for teaching this subject used to avoid it. Earlier, the appointment criteria for SST (previously known as SET) was B.A. B.Sc. plus B.Ed. for Art and Science teachers. Figure 1 illustrates the academic qualification to be eligible for the SST post.

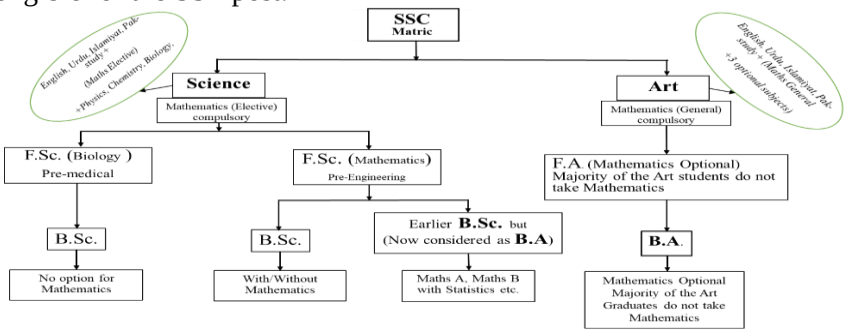

Figure 1. Academic hierarchy of SST teachers

Figure 1 shows that elective mathematics is offered to SSC Science group while SSC arts group is offered general mathematics. In F.A., mathematics is optional. Very few of the students take mathematics in their F.A. (Board of Intermediate and Secondary Education (BISE) Peshawar gazette, 2016), while majority avoid it. Similarly, in B.A., it is also optional. In F.Sc. Pre-Medical there is no option for mathematics.

All those teachers, who came across F.Sc. Pre-medical or F.A. with no Mathematics, their Mathematics' comprehension level is said to be as SSC, but yet, they were considered eligible for appointment on SST post in the past, on the bases of B.A/B.Sc. (with or without mathematics). The fact is that they had not been experienced in this subject in their F.A/F.Sc. and/or B.A./B.Sc. So, most of the already appointed SSTs are currently working in the field with the said qualification and they are facing difficulties in teaching this subject.

The appointment criteria for SST general is still the same i.e., B.A. with or without Mathematics and are responsible for teaching the Arts Group General Mathematics whereas the old-fashioned SST science post has been classified into SST Math-Physics and SST Bio-Chemistry. Only those are appointed on SST Math-Physics who have read Mathematics and Physics in their B.Sc. and they are responsible for teaching Mathematics and Physics.

Rationale of the Study

A teacher must be equipped with the content knowledge as well as a sound teaching technique (National Research Council, 2000) to produce the required results. So, in this phenomenon, how can we expect from the teachers to produce excellence in Mathematics? If they are comparatively less competent in mathematics content knowledge and have passed B.Ed. professional examinations a private candidate. On the other hand, those teachers, who have been trained in pedagogies with excellent academic record are using only two tools (chalk/marker and board) to teach mathematics whereas hundreds of resources and materials are easily available just on a few clicks to everyone in this age of modern technology. So, content knowledge of the teachers and pedagogies needs to be upgraded.

The teachers of Khyber Pakhtunkhwa are still dependent on their traditional methods of educating their students in Mathematics in this new era of science and technology. No clear common pattern has yet been emerged that would mention how to teach the Mathematics contents effectively in a traditional classroom environment. There is a need to adopt modern technologies and new teaching methods to improve the

quality and quantity of education (Akhtar, 2009). Currently, computers and its related technologies have affected almost every aspect of life and nearly most of the subjects have a technological touch including mathematics. Numerous research studies have indicated impressive academic achievements of students in a variety of subjects including mathematics after integrating new technologies into teaching. Therefore, it is needed to welcome these new trends; to pursue the updated methods for reforming the current settings in education, to assess the impact of these new technological trends and renewed methods in our mathematics classroom environment and, to investigate its scope in teaching learning process.The purpose of this study was to examine the impact of Computer-based Instructional (CBI) method in the teaching learning process of mathematics considering the 9th-grade Science Group students in district Peshawar for the school academic year 2016-17 through a standalone computer and to compare it with the traditional instructional method.

Objectives of the study

The Objectives of this study were to introduce Computer-based Instructional method in the 9^{th} grade mathematics to improve learning and to compare it with the traditional method in understanding Mathematics.

Research Hypotheses

The following hypothesis were tested

$H_0$1. There is a significant difference in the mean post-test scores of the students taught with the help of computers and those taught by traditional method.

$H_0$2. There is a significant difference in the mean retention-test scores of the students taught with the help of computers and those taught by traditional method.

Delimitations and Limitations of the Study

This study was delimited to only two chapters of the textbook of "Mathematics" for the 9th-Grade Science Group, approved for KPK and FATA by Federal Ministry of Education Curriculum Wing Islamabad, Government of Pakistan. Only male students were taken for this study.The study lasted for 12 instructional days and was thus limited in duration.

Literature Review

Mathematics is one of the core subjects which stuck with the students throughout their academic career and play a prominentrole. Several international agencies like National Council of Teachers of Mathematics (NCTM), International Mathematical Union (IMU), the Program for International Student Assessment (PISA), and Trends in International Mathematics and Science Study (TIMSS) are working for the advancement of mathematics and mathematics education.

Mathematics curriculum is becoming more dynamic and interactive due to the speedy growth of new technologies. With the introduction of computers in the teaching learning process, the students are more engaged and independent in acquiring knowledge(Solano, Cabrera, Ulehlova, & Espinoza, 2017).The approach of integrating computer Software programs like tutorials, drills and practices, instructional games, simulations and other materials into teaching is called Computer-based Instruction, also known as computer-assisted instruction (CAI), Computer-based training (CBT), and computer-assisted learning (CAL) (Kropf, 2017).

Educators/experts differ in defining Computer-based Instruction. They define it according to their own learning situations; however, they mostly agree upon this point that this term is commonly used for computers when it assists or delivers some instruction for learning Greene (1991) is of the view that CBI is an educational tool in which computers, instructional software and pedagogical knowledge of the teacher is used to help students in understanding the contents through training.

Figure 2depicts the terms of computer's involvement in teaching learning process.

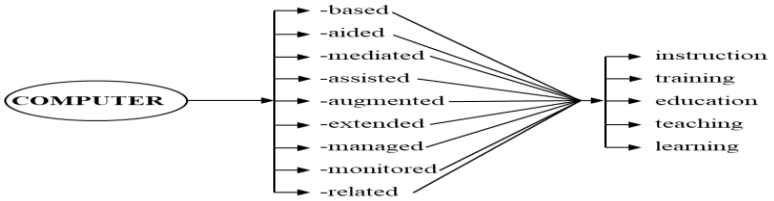

Figure 2. Terms used for computer's interaction in education or training

There are some commonly used terms which refer to the use of computers in education for instructional purposes. They are: Computer-based learning, Computer-assisted instruction, Computer-assisted learning, Computer-based training, Computer-based education, Computer-based Instruction, Computer Managed Instruction and

Computer Enriched Instruction (Tabassum, 2004). Serin (2011) is of the view that when computer is used for instructional purposes, it is known as CBI.

Methodology and Procedure

This study used the 'Post-Test only Control Group Experimental Design'. The research approach was quantitative.

Population: The population for the study was 3369 students reading in the 9th-grade science group in the 106 male Government schools (High and Higher Secondary) of district Peshawar, in session 2016-17 (Education Management Information System (EMIS), 2015).

Sample: Purposive sampling technique was used. For a population of 3369 students, the recommended sample size was calculated as 350 using the Krejcie and Morgan's formula (Krejcie & Morgan, 1970).

Data Sources and Collection Tools

Data were collected from the 9th graders through self-made achievement tests. The self-made achievement test was offered to both the groups. The same contents were again presented to them after twelve weeks of the post-test to observe the retention power of the students.

Validity and Reliability of the Instruments

The contents of the achievement tests, as well as the instructional objectives, were submitted to five subject experts to check and analyse its validity (Hord, et al. 1999). Few minor changes were made accordingly in the light of the experts' review. Moreover, a split-half reliability was measured. So, all the test items were randomly split into two halves. The two halves of the test were given to students. The correlation between the two halves were found to be .75, which ensured consistency.

This study adopted CBI in a cooperative learning environment for mathematics. The students were equated into experimental and control groups. They were taught with CBI and traditional methods for 12 consecutive school days. Ten instructional hours' treatment was provided to each of the groups.

Data Analysis and Interpretation

An independent sample *t*-test at *.05* level of significance was applied to find out the significant difference between the mean score experimental and control groups

The following hypotheses were tested to assess the performance of the two groups.

Hypothesis No. 1

There is a significant difference in the mean **post-test** scores of the students taught with the help of computers and those taught by traditional method.

H_0: μExp ≠ μCtrl H_1: μExp = μCtrl

Table 1 *Experimental versus Control Group*

Group	*N*	*Mean*	*SD*	*t*	*df*	*P-value*
Experimental	175	43.64	12.732	3.284	348	.001
Control	175	39.30	11.962			

** Significant* ** p < .05*

The distributions of experimental and control groups were sufficiently normal for the purposes of conducting an independent sample *t*-test. Homogeneity of variances was examined and satisfied through Levene's test which indicated equal variances (F = .924, p= .337). So, an Independent sample *t*-test was applied. Results of the independent samples *t*-test in

Table ***1*** shows the mean score difference between experimental (M = 43.64, SD = 12.732, N= 175) and control (M = 39.30, SD = 11.962, N= 175) groups at .05 level of significance (t = 3.284, df = 348, p=.001). The results showed that Experimental group have higher mean score than the control group. Hence, the difference is statistically significant, so, the hypothesis cannot be rejected. Thus, the CBI really have improved students' performance.

Hypothesis No. 2

There is a significant difference in the mean **retention-test** scores of the students taught with the help of computers and those taught by traditional method.

H_0: μExp ≠ μCtrl H_1: μExp =μCtrl

Table 2 Experimental versus Control Groups

Groups	*N*	*Mean*	*SD*	*t*	*df*	*P-value*

Experimental	175	40.30	12.66	3.113	348	.002
Control	175	35.99	13.22			

** Significant* ** p < .05*

Table *2* shows that the score of the experimental group *(M*=40.30, *SD*=12.66) was higher than the control group *(M*=35.99, *SD*=13.22) on the retention-test, and the difference was large enough to be statistically significant conditions' (348) =3.113, *p*= .002). The distributions of experimental and control groups were sufficiently normal for the purposes of conducting a *t*-test. Homogeneity of variances was examined and satisfied through Levene's test which indicated equal variances (*F* = .939, *p*= .333). So, the results suggest that the experimental group performed statistically significant as compared to the control group on the retention-test. The hypothesis, "there is a significant difference in the mean retention-test scores of experimental and control groups" cannot be rejected. Thus, CBI really have enhanced students' retention of the subject matter.

Findings

The concept of technology integration in our schools is absent until now because most of our teachers are not professionally trained in this regard. The over-crowded classrooms make it more difficult for teachers to pay attention to a class of 100 students. To some extent it seems difficult to utilise Computer-based instruction in that kind of classrooms but from the literature review, it is clear that CBI has the potentials to enhance the students' performance to a higher level (Brahier, 2016; Adigun, Madu, & Okulaja, 2015; Cem & Mustafa, 2011; Al-Mujaini, 2006; Angers, 2004).

The statistical analysis showed a significant difference between the performance of the experimental and control groups in favour of experimental group on post-test which is supported by Singh (2019) as well as retention test which is supported by Bhatti (2019) in retention of mathematical concepts; however, the result obtained on learning from a meta-analysis of the quantitative studies of Computer-based Instruction by Azevedo and Bernard (1995) showed variations on post-test as well as on retention-test.

Conclusions

The findings confirmed that CBI enhanced educational process and produced more learning. It was concluded that Computer-based Instructional method enhanced the performance of the 9th-grade students

significantly better than the traditional method on the post-test as well as retention test.

Recommendations

1. CBI improved learning. Thus, it is recommended at Secondary School level in mathematics.
2. Technological tools like computers and mathematics-related computer software along with appropriate teaching methodologies should be integrated in mathematics classroom to enhance mathematical learning.
3. The advent of fast and easily accessible 4G internet services has made it possible to transform CBI from a standalone platform to an integrated learning system. So, educators need to research in this area.

References

Adigun, F. A., Madu, S., & Okulaja, A. A. (2015). Effects of computer based instructional strategy on students' academic achievement in senior secondary school biology in Ogun state Nigeria. *Atlantic, 1*(1), 1-7.

Akhtar, S. H. (2009). A critical study of the use of educational technology at secondary school level in Pakistan: a case study of the Province of NWFP. *(Doctoral Dessertation)*. Hyderabad: University of Sindh.

Al-Mujaini, E. Y. (2006). *The integration of computer technology in an eighth-grade male social studies classroom in the United Arab Emirates*. Doctoral dissertation, Ohio University.

Angers, J. D. (2004). *Integrating a technology-enriched curriculum ethno-case study.* (Doctoral dissertation): McNeese State University.

Azevedo, R., & Bernard, R. M. (1995). A meta-analysis of the effects of feedback in computer-based instruction. *Journal of Educational Computing Research, 13*(2), 111-127.

Bhatti, N. (2019). CAI and conventional method for retention of mathematics: an experimental study. In Journal of Physics: Conference Series. *International Conference on Mathematics and Science Education, 1157*(3). doi:10.1088/1742-6596/1157/3/032079

Brahier, D. J. (2016). *Teaching secondary and middle school mathematics. Routledge.* (5th, Ed.) Routledge.

Cem, O. G., & Mustafa, D. (2011). The effect of computer use in science and technology lesson on success and attitude towards. *Journal of Social Sciences, 7*(4), 498-503.

Gazette Statistics. ''Board of Intermediate and Secondary Education (BISE) Peshawar gazette.'' 2016.

Greene, R. A. (1991). *An Experimental Study in the Use of Computer-Based Instruction to Teach Automated Spreadsheet Functions.* (No. Afit/glm/lsr/91s-24). Air force institutio of technology wright-Patterson Air Force base ohio.

Hord, S., Meehan, M. L., Orletsky, S., & Sattes. (1999). Assessing a School Staff as a Community of Professional Learners. *Issues... about Change, 7*(1).

Khan, W. (2015). Quality of teacher education in Pakistan. *The Dialogue, 10*(2), 212-219.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement*, 607-610.

Kropf , D. (2017). *What Is Computer-based instruction in education?* Retrieved 12 12, 2017, from classroom: http://classroom.synonym.com/computerbased-instruction-education-6081722.html

National Research Council. (2000). *How people learn: Brain, mind, experience, and school: Expanded edition.* Washington, D.C: National Academies Press.

Reuben, R. S., Guimba, W. D., & Alico, J. C. (2016). Assessment of Mathematics Teachers in a Public and a Private School: Implications to the Quality of Teaching Secondary Mathematics. *Advances in Sciences and Humanities, 2*(2), 7-16. doi:10.11648/j.ash.20160202.11

Serin, O. (2011). The Effects of the Computer-Based Instruction on the Achievement and Problem Solving Skills of the Science and Technology Students. *Turkish Online Journal of Educational Technology-TOJET, 10*(1), 183-201.

Singh, P. (2019). A comparative study to evaluate the effectiveness of traditional class room lecture versus computer assisted instruction at senior secondary level. *International Journal of Physiology, Nutrition and Physical Education, 4*(1), 96-100.

Solano, L., Cabrera, P., Ulehlova, E., & Espinoza, V. (2017). Exploring the use of educational technology in EFL teaching: A case study of primary education in the south region of Ecuador. *Teaching English with technology, 17*(2), 77-86.

Tabassum, R. (2004). *Effect of computer assisted instruction (CAI) on the secondary school students' achievement in science.* (Doctoral dissertation, University of Arid Agriculture Rawalpindi, Pakistan).

Wekesa, D. W. (2017). Computer Based Instruction: A Springboard to Students Performance in Mathematics. *International Journal of Innovative Research and Development, 6*(1), 39-45.

Zakaria, E., Chin , L. C., & Daud, M. Y. (2010). The effects of cooperative learning on students' mathematics achievement and attitude towards mathematics. *Journal of social sciences*(6), 272-275.