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Effectiveness of Computer-Assisted Instruction in Urdu Language for Secondary School Students' Achievement in Science

Muhammad Khalid Mahmood, Ph.D. in Education
Munawar Sultana Mirza, Ed.D.

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Abstract

This experimental study examined effectiveness of the computer assisted instruction (CAI) on students' achievement in general science as compared with the traditional method of instruction (TMI). This experimental study was conducted in a public secondary school in Lahore, Pakistan. Post-test only control group experimental design was employed on paired groups matched with respect to intellectual capacity of the students. The CAI program comprising interactive tutorials in Urdu language was used for learning by the experimental group. The control group was taught the same content in the classroom by the teacher through textbook based lecture method, which is the traditional method of teaching in public schools in Pakistan. An achievement test assessing knowledge, comprehension and application components of learning was administered to both the groups after a two month long treatment period. The experimental group performed better on all the three components of the achievement test as compared to the control group. The CAI group also scored higher than the TMI group in various content areas of general science.

Introduction

Teaching methods and instructional techniques in the classrooms have been changing influenced by learning theories and technological advancements. Maddux, Johnson and Willis (1997) ascribe changes in instructional practices to cultural changes. Technology has changed the whole pattern of human life. The greatest contribution of cyber age technology is the development of computer and its use in all walks of life. The use of computer in teaching learning process has stepped many stages of its evolution. A host of research studies have been conducted to explore the effectiveness of Computer Assisted Instruction in various fields of study and at different grade levels.

Computer-assisted instruction is the process by which written and visual information is presented in a logical sequence to a learner through a computer. The student learns by reading the text material presented or by observing the graphic information displayed. Some of the programs provide audio-visual presentation with an option to the student to select audio presentation in addition to the visual media. Each segment of text is followed by questions, for student's response. Feedback on response is indicated immediately (Locatis & Atkinson, 1984; Wang & Sleeman, 1993). CAI can be characterized as interactive and individualized learning as it usually involves a dialogue between one student and a computer programme and student can learn at his own pace and time frame (Curtis & Howard, 1990).

The mode of presentation of CAI has been changing with the advancements in hardware technology and software development techniques. Learning theories have also been a source of change in computer assisted instruction. The use of computer for behaviorist theory based programmed instruction started in late 1960s. Initial stages of computer technology made possible only behavioral theories based drill and practice programs of CAI. Cognitive theories and invention of personal computers gave CAI the shape of tutorials. More advancement in computer technology gave birth to more interactive programs like simulations. With the advancement of technology new dimensions of CAI have emerged. Bucholtz (1999) adds new meaning to CAI by using this term for internet based instruction

through the use of web pages, web bulletin boards and real audio, graphics and hands-on-applications.

Effectiveness of CAI

There is ample evidence for effectiveness of CAI in various subject areas and at various grade levels. Yusuf and Afolabi (2010) found CAI as an effective mode of instruction for teaching Biology to secondary school students both in individualized and cooperative settings. Singh (2010) demonstrated that simulation mode is more effective than tutorial and drill and practice modes of CAI for teaching science to 9th grade students. Barad (2010) found science teaching through CAI more effective for high IQ students than low IQ students of 9th grade. Kumar (2010) tested the effectiveness of CAI for teaching general science at secondary level and found positive results in favour of CAI as compared with conventional method. Hancer and Tuzemen (2008) found CAI more effective as compared to traditional method for teaching science at primary school level. Raninga (2010) proved CAI as an effective method for teaching mathematics to 7th grade students as compared with traditional method. Ragasa (2008) and Basturk (2005) found CAI more effective than traditional lecture method for teaching introductory statistics to college students.

Poole (1997) have exemplified some successful computer assisted instruction programs and projects and cited findings of research studies as an evidence for the effectiveness of CAI in 'reading', 'writing', 'Arithmetic and problem solving', 'science', and 'social studies', at all grade levels i.e. from primary to K-12.

Cotton (2001) reviewed fifty nine research studies exploring effectiveness of CAI and concluded that the CAI utilized as a supplement to the teacher directed instruction resulted in superior students' achievement. Christmann, Badgett & Lucking (1997) conducted a meta-analysis of the studies comparing CAI, Traditional methods of Instruction and Traditional method of instruction plus CAI. It was found that students receiving Traditional method of instruction supplemented with CAI attained higher academic achievement than those receiving only traditional instruction or CAI.

Roblyer (1988) also found that students who received science instruction through CAI simulations achieved more than those who studied in a conventional learning environment. It was also found that CAI activities are most effective in the areas of science and foreign languages.

Helgeson (1988) reviewed studies determining the effectiveness of CAI in science classroom and science laboratories and found evidence in support of CAI, as laboratory activities and simulations and combination of two strategies yielded higher achievement than did conventional instruction. Findings of the studies conducted by Brophy (1999); Bayrakter (2000) and Carter (1999) also support effectiveness of CAI in science.

Development and Utilization of CAI is not very common in Pakistan. However, the National Education Policy (1998-2010) aims at modernizing education in Pakistan via the application of information technology at all levels. It also emphasizes the different roles of computer as a learning tool in the classrooms.

Present study was designed to explore the effectiveness of CAI program developed by the researchers, presenting learning material in Urdu language.

Objectives of the study

Main objectives of this experimental study conducted in a public secondary school in Pakistan were to:

- determine the effectiveness of the CAI in Urdu language on students' learning general science as compared to the textbook based traditional method of instructions.
- determine the effect of the CAI on students' learning of different content areas of general science i.e. Physics, Chemistry, Biology.
- determine the effect of the CAI on students' knowledge, comprehension and application domains of learning.

Methodology

Design of Experiment

Post-test only control and experimental group design on intellectual capacity wise matched groups was employed in the present study. Raven's Standard Progressive Matrices were used to measure the intellectual capacity of the students for paired matching.

Selection of Participants

Forty students out of total eighty 9^{th} graders of general science group were selected on the basis of intellectual capacity measured on Raven's Standard Progressive Matrices. Twenty pairs perfectly matched on intellectual capacity were assigned randomly to experimental and control groups.

Development of CAI Program

The experiment aimed at comparing the CAI with the Traditional Method of Instruction (TMI) which utilizes text book as the main tool for teaching and learning. It was logical to present the same text as given in text book to the experimental group through the CAI. Tutorial form of computer-assisted instruction was found to be more feasible to serve the purpose.

This program covered a text content of four chapters from the text book of general science for 9^{th} and 10^{th} classes. This text content was selected keeping in view the expected dates and period of treatment. Text material was divided into small segments for presentation in tutorials, each text segment was followed by multiple choice questions and feedback on responses to MCQs to assess and support students' learning. Explanations for terms and concepts in the text were presented through hyperlinks. Software was developed by utilizing in Microsoft flash.

Theoretical Foundations of CAI Programme

Theoretical orientation of the software used in the present study was developed by the researchers with eclectic approach in mind. Eclectic approach uses principles and techniques from different perspectives as suit the situation at hand (Huffman, Vernoy & Vernoy, 1995). Drill and practice software is oriented to behaviourist approach and works well to memorize and refine skills (Allessi & Trolip, 1995; Hsu, Chen & Hung, 2000; Maddux, Johnson & Willis, 1997: Roblyer & Edwards, 2006). Hsu, Chen & Hung (2000) assert that tutorial programmes are associated to cognitive theories of learning. Roblyer & Edwards (2006) also contend that tutorials can be designed to adopt Piaget's cognitive approach. Tutorials with branching mode of presentations tend to shift their orientation from cognitive to constructivist approach. The programme mainly underlies cognitive approach but behaviorist and constructivist orientations are also prevalent in it as:

- A large number of multiple-choice questions along with feedback on responses characterized the program as drill and practice.
- Text presented in tutorials and explained through hyperlinks made it interactive in nature. Text segments followed by MCQs and feedback on each option of MCQ associated it with cognitive perspective of learning.
- Nature of questions that explores comprehension and application components of cognitive domain and branching mode of presentation due to hyperlinks and feedback blended the programme with constructivist approach.

Treatment

The experimental group was given a treatment in the form of computer-assisted instruction in the computer lab of the school. One of the researchers supervised the experimental group. The control group received instruction from its class teacher as usual. Both the groups were told that their achievement would be tested after completion of treatment.

The salient features of the treatment were embedded in the software used by experimental group. Main characteristics of the software were:

Mode of presentation: Tutorial mode of presentation was employed in the program as it was to be used to deliver the entire instructional sequence similar to the teachers' classroom instruction on the topic. To enrich learning the unfamiliar terms and concepts were explained through hyperlinks. Multiple choice questions along with feedback on each option followed each text segment so that students may keep track of their own learning.

Multiple choice questions: A distinguishing characteristic of the program is multiple choice questions incorporated in it. A conscious effort was made to make the questions thought provoking to explore knowledge, comprehension and application abilities of the learners. These MCQs and feedback on their options made the programme more effective for learning.

Post test: An Achievement Test comprising one hundred multiple choice items was developed to measure the knowledge, comprehension and application abilities of the students. Percentage of items measuring knowledge, comprehension and application components of achievement was forty, forty and twenty, respectively. Necessary procedure for test development i.e. preparation of chart of specifications, item construction, reviews of the items, content validation, piloting to determine the psychometric properties of the items was followed.

Achievement test was administered to both the experimental and the control groups. Achievement scores of students for both the groups were used to compare the student learning through computer-assisted instruction and traditional method of instruction.

Data Analysis

As the groups were dependent on intellectual capacity, Paired *t*-test was applied to compare the overall, by cognitive levels and by content area achievements of the experimental and the control groups.

Expected scores of the experimental group were also computed through the linear regression equation of the control group data. Trend lines for expected and observed achievement scores across the intellectual capacity score were also drawn for visual presentation of difference.

Comparison of Overall Achievement

Paired *t-test* was employed to compare overall achievement of the experimental and control groups. Summary of analysis is presented in proceeding table.

Table 1

Analysis of overall achievement scores of the experimental and the control groups

Group	N	Mean	Std. Dev.	Paired Differences		*t*	Sig. (2-tail)
				Mean	Std. Dev.		
Experimental	20	44.05	9.42	9.75	7.03	6.20	.000
Control	20	34.30	3.64				

Overall mean achievement scores of experimental and control groups on post test were found to be significantly different beyond 0.05 level of significance. It was concluded that students who received CAI showed significantly better achievement than the students who received instructions in traditional manner. However, the achievement scores of experimental and control groups indicate low overall scores of the students.

The reason for overall low scores becomes obvious when composition of the groups is viewed. Each of the experimental and the control group consisted of eleven students with definitely below average in intellectual capacity, seven students with average intellectual capacity and only two were above average in intellectual capacity. Majority of the students in each group who were definitely below average in intellectual capacity pulled down the mean score.

Difference between expected and actual scores of the Experimental group

Analysis on overall achievement scores of the experimental and control group was done by computing expected achievement scores of the experimental group on the basis of linear regression equation for control group data. To find the equation, linear regression analysis was run on control group data by keeping intellectual capacity scores as predictor and achievement scores as criterion variable. The following table presents a summary of coefficients for regression analysis.

Table 2

Summary of coefficients for regression analysis

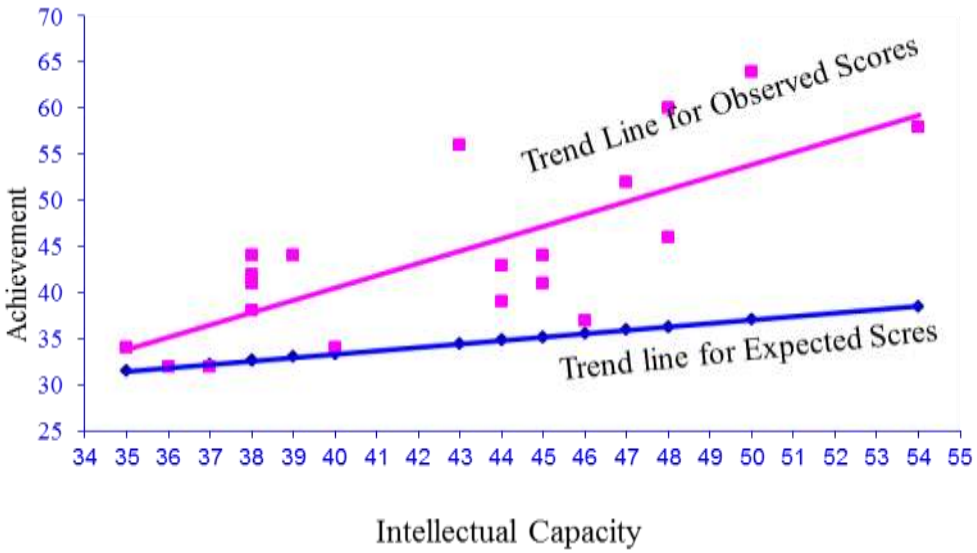
Model	Unstandardized Coefficients		Standardized Coefficients	*t*	Sig.
	B	Std. Error	B		
(Constant)	18.641	5.690		3.276	.004
Intellectual capacity scores	.368	.133	.547	2.773	.013

Regression equation based on analysis summarized in above table was formulated as: Achievement scores= 18.641+.368(intellectual capacity scores).

Applying this equation to experimental group data i.e. putting the values of intellectual capacity scores of the experimental group, expected achievement scores of the experimental group were computed. Trend lines representing expected and observed scores are shown in figure below.

Figure1

Comparison of Observed and Expected Achievement Scores of the Experimental Group



Slopes of trend lines on scatter plots of expected and observed achievement scores make the difference obvious. Better observed learning trend can be attributed to the mode of instruction i.e. computer assisted instruction experienced by the experimental group

Comparison of Knowledge Component of achievement

Paired *t*-test was applied to examine the significance of difference between mean scores of the experimental and the control groups on knowledge component of achievement test.

Table 3

Summary of paired t-test comparing knowledge of experimental and control groups

Group	N	Mean	Std. Dev.	Paired Differences		*t*	Sig. (2-tail)
				Mean	Std. Dev.		
Experimental	20	45.00	10.42	8.625	11.39	3.384	.003
Control	20	36.375	6.90				

Significant value of *t* at 0.05 level of significance revealed that the students of the experimental group who received CAI performed better on knowledge component of achievement test than those who were taught through traditional method of instruction.

Comparison of Comprehension

Comprehension of the experimental and the control group students was compared on 40 MCQs in the post test.

Table 4

Summary of paired t-test comparing comprehension of experimental and control groups

Group	N	Mean	Std. Dev.	Paired Differences		*t*	Sig. (2-tail)
				Mean	Std. Dev.		
Experimental	20	43.875	11.07	9.875	13.14	3.361	.003
Control	20	34.00	7.18				

Summary of statistical test shows that t- value is significant at 0.05 level of significance. Finding of the test leads to the conclusion that the CAI recipients had significantly better mean score on comprehension component of post test as compared to mean score of TMI group.

Comparison of Scores on Application Component of Achievement

Post test included 20 MCQs assessing students learning at application level of cognitive domain.

Table 5

Difference between the scores of experimental and the control groups on application component of the achievement test

Group	N	Mean	Std. Dev.	Paired Differences		*t*	Sig. (2-tail)
				Mean	Std. Dev.		
Experimental	20	42.5	16.42	11.75	15.58	3.372	.003
Control	20	30.75	12.16				

Experimental group's mean score on application component of post test was found to be significantly better than that of control group. Analysis revealed that CAI group performed better on, knowledge, comprehension and application components of achievement.

Comparison of Achievement in Biology

General science taught at secondary school level is a blend of Biology, physics and chemistry. Achievement in biology, taught during experiment was assessed on post test. Achievement of both the experimental and control groups was compared by employing t-test.

Table 6

Difference between the achievement scores of the experimental and the control groups in biology

Group	N	Mean	Std. Dev.	Paired Differences		*t*	Sig. (2-tail)
				Mean	Std. Dev.		
Experimental	20	44.77	11.26	10.44	8.65	5.397	.000
Control	20	34.33	6.54				

Results revealed that there was a significant difference between the mean achievement scores of the experimental and the control groups at 0.05 level of significance. Hence CAI in the present experiment proved more effective in the learning of biology than the traditional method of instruction.

Comparison of Achievement in Chemistry

Achievement of experimental and control group in chemistry content taught during experiment was also compared to find out the significance of difference.

Table 7

Difference between the achievement scores of the experimental and the control groups in chemistry

Group	N	Mean	Std. Dev.	Paired Differences		*t*	Sig. (2-tail)
				Mean	Std. Dev.		
Experimental	20	46.875	13.79	10.78	14.39	3.350	.003
Control	20	36.093	6.20				

Results of paired *t*-test revealed a significant difference between mean achievement scores of the experimental and the control groups at 0.05 level of significance. Hence the CAI was proved better for achievement in the content area of chemistry than the TMI.

Comparison of Achievement in Physics

Experimental and control group students' achievement in physics content was also compared.

Table 8

Difference between the achievement scores of the experimental and the control groups in physics

Group	N	Mean	Std. Dev.	Paired Differences		*t*	Sig. (2-tail)
				Mean	Std. Dev.		
Experimental	20	38.69	11.96	6.95	11.58	2.686	.015
Control	20	31.73	11.02				

Again significant difference in the mean achievement scores of the experimental and control groups in physics led to the conclusion that the CAI was more effective in learning physics as compared to the TMI.

Conclusion

Computer assisted instruction is a better method of instruction for secondary level general science as compared to the traditional method of instruction, as a whole, by selected levels of cognitive domain i.e. knowledge, comprehension and application and is equally good to teach the content areas of biology, chemistry and physics.

Discussion

Results of the study demonstrated that computer assisted instruction was an effective mode for knowledge, comprehension and application domains of learning as well as for learning in all content areas of general science i.e. biology, chemistry and physics.

The results of the present study are in consonance with the results of many of the experimental studies demonstrating effectiveness of CAI for better student achievement in science and mathematics such as Yusuf and Afolabi (2010), Singh (2010), Barad (2010), Kumar (2010), and Hancer and Tuzemen (2008), Brophy (1999), Carter (1999), Bitter and Pierson (1999), and Bayrakter (2000). Review of studies determining the effectiveness of computer assisted instruction by Helgeson (1998) found precedents in support of CAI for

science. Meta analysis of researches regarding effectiveness of CAI by Roblyer (1989) revealed that effectiveness of computer assisted instruction depends upon the quality and utilization of CAI software. Computers are highly promising educational tools but it is the way computers are used rather than the actual machines themselves that contribute to learning. The effectiveness of computer assisted instruction for improved student learning as demonstrated by the present study may be attributed to the software used in the experiment and the way it was used.

The software used in the study was developed by the researchers as no software was available to serve the purpose. Educational software development is not the task of an individual. It requires a team effort and host of resources. In spite of these limitations software used in the experiment proved effective for student learning as compared to traditional classroom instruction.

The Government of the Punjab emphasizes use of Information Technology (IT) in Schools and has provided computer laboratories to a large number of secondary schools. The teachers and educational authorities should make wise decisions about different ways of using computer to enhance quality of student learning and to maximize utilization of this teaching and learning tool. Through CAI, quality instructions can be taken to school at lower cost for students of varying learning abilities. A large number of educational softwares are available at World Wide Web. Department of Schools Education should subscribe relevant softwares for school use. Educational software can be used to explain the concepts and processes in such a manner that is not possible through traditional practices. Use of computer assisted instruction for science subjects is indispensable and cost effective.

Private tuition has become a social evil in our society. Evil practices associated with private tuition have a negative effect on the quality of education in public schools. Computer assisted instruction can be used to supplement student learning at school in a much better way than the private tutor. It requires provision of educational software and access to computers. Providing the children with computers and educational software is cost effective than paying tuition fee. Computer assisted learning centers can be established in educational institutions to serve the needs of the students after school time. Those who cannot afford tuition fee can

also benefit from these learning centers. Computer assisted instruction will also facilitate individualized instruction at learner's own pace.

Recommendations

Potential of computer assisted instruction should be utilized to enhance quality of student learning in various subjects especially in science at school level. Software for computer assisted instruction is a pre-requisite and its development is not an individual's task. Institutional set up is needed to develop educational software for different subject areas and grade levels and to organize and coordinate utilization of computer assisted instruction in schools. Pre-service teacher education programs are needed to be enriched to enable prospective teachers to find ways to use CAI. There should be capacity building progammes for in-service teachers to enable them utilize CAI.

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Muhammad Khalid Mahmood, Ph. D. in Education
Assistant Professor
Division of Education
University of Education
College Road, Township Lahore
Pakistan
khalid.peas@gmail.com

Munawar Sultana Mirza, Ed. D.
Professor Emeritus at Institute of Education and Research (IER)
University of the Punjab
Lahore
Pakistan
dr.mmirza@hotmail.com