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Effect of Computer Assisted Instruction (CAI) on Secondary School Students' Achievement in Science

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Abstract

Computer-assisted instruction (CAI) is an interactive instructional technique whereby a computer is used to present the instructional material and monitor the learning that takes place.

This study was designed to see the effect of computer-assisted instruction as a supplementing strategy on the academic achievement of secondary school students in the subject of science. The major objectives of the study were: (1) To find out the relative effects of computer-assisted instruction as a supplementing strategy on academic achievement in science; and (2) To investigate the difference between treatment effects on male and female students. To achieve the objectives of the study, the following null hypotheses were tested: (1) There is no significant difference between the mean scores of the students taught science with CAI as supplementing strategy and without CAI; and (2)

There is no significant difference between the mean scores of male and female students of experimental and control groups.

Secondary school students studying science subjects constituted the population of the study. The students of 9th class of The City School, H-8, Islamabad, were selected as

sample of the study. Only students studying biology as an elective subject were included in the sample. Sample students were assigned to either the experimental group and or control group. Both the groups were equated on the basis of their achievement scores in previous semester in the subject of biology. Each group comprised 20 students.

There were two different treatment patterns applied during the experiment. Both the groups were taught through routine method by the same teacher. Computer-assisted instruction was used as additional strategy for the experimental group. During the experiment period, the experimental group received the treatment of. computer-assisted instruction whereby the students were exposed to certain web-cites consisting of drill and practice, tutorials, simulations and animation. Meanwhile the control group was kept busy in other activities such as guided practice and independent practice. This was adopted to control the variable of time and to realize the primary objective of the study. The experiment continued for six weeks. In order to find out treatment effects, a teacher-made post-test was administered to the experimental as well as control group immediately after the treatment (teaching) was over.

Significance of difference between the mean scores of both the groups on the variable of previous achievement was tested at .05 level by applying t-test. To see the treatment effects for male and female students both the groups, the factorial design (2 X 2 analysis of variance) was applied.

Analysis of data revealed that the students taught through computer-assisted instruction as supplementary strategy performed significantly better. Computer-assisted instruction was found equally effective for both male and female students.

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1. Introduction

Computers are already in use in Pakistan in banks, large firms, transport companies, the armed forces and elsewhere. Either owing to excessive compartmentalization of administrative departments or to the relative order of political priorities, it did not appear that the Ministry of Education was ever involved at higher levels of decision-making. With the growing use of computers in education and instruction, computer training for teachers and teacher-educators is being considered a prime objective for the advancement of educational technology (Aubineau, 1986).

Teachers use computers for instruction. Computers are not like tools such as black board or textbooks. Rather, they are devices that provide students with interactive involvement with instructional materials. This is the advantage for which it is said that CAI contributes towards the quality of education. Some of the benefits are:

1. Students may be given various degrees of control over their own learning.

2. Instruction can be tailored according to individual student's needs.
3. Feedback on student performance can be stored for further reference.

As the name implies, the basic interaction in computer-assisted instruction (CAI) occurs between the learner and the computer. It is self-paced and in many respects is very similar to programmed learning except that the instructional package is in the form of computer programme. Instruction usually proceeds step-by-step using a video display. The learner answers questions and calls up the next learning sequence by using the computer terminal. The system is more interactive than programmed instruction because the learner can select from a wider range of options and can be required to make more complex decisions (Farooq, 1997).

There are two major types of CAI – adjunct (first used by Victor Bunderson) and primary. Adjunct CAI consists of materials that supplement or enrich the learning situation, e.g., short CAI programmes and those support concepts, which are to be discussed later in the regular class. Primary CAI materials conversely provide instructions of a substitute and of usually longer duration. It is also part of distance learning throughout the world.

CAI programs use tutorials, drill and practice, simulation, and problem-solving approaches to present topics and they test the students' understanding. These programs let students progress at their own pace, assisting them in learning the material. The subject matter taught through CAI can range from basic math facts to more complex concepts in math, history, science, social studies and language arts (Sharp, 1996).

Two major types of CAI are identified as adjunct (first used by Victor Bunderson (Kearsley, 1982) and primary. **Adjunct** CAI encompasses materials that supplement or enrich the learning situation. For example: short (half – to one-hour) CAI programs that support or illustrate concepts discussed in the regular classroom. **Primary** CAI materials, conversely, provide instruction of a substitute or stand-alone variety and are usually of longer duration (Chambers and Sprecher, 1983).

Computer-assisted instruction (CAI) is defined as the use of computer to provide course content instruction in the form of drill and practice, tutorials, and simulations. Drill and practice is a common CAI form in which a type of repetitive, or "flash card," approach emphasizes rote memory. It is used extensively at all educational levels (Chambers and Sprecher, 1983).

Tutorials use the computer in a higher-level mode in which question-and-answer, dialogue-type learning in the traditional tutor mode is emphasized. Like drill and practice, it is used extensively at all educational levels. A kind of dialogue takes place between student and machine. CAI tutorials are based on the principles of programmed learning: The student responds to each bit of information presented by answering questions about

the material and then gets immediate feedback on each response. If the student answers correctly, the next frame appears on screen.

Simulations, the third type of CAI, provide a model in which the student plays a role and interacts with the computer. Simulations have been used most often in higher education to model scientific processes. They are applicable to any field, however, and can be of significant help in illustrating concepts, in helping students to develop problem-solving techniques, or in allowing students to explore complex interactions.

Computer-assisted instruction satisfied many of the theoretical requirements for a "good" learning environment advanced by leading psychological theorists such as Skinner (1968). Thus, it involves the individual actively in the learning process, which supposedly facilitates learning (Mckenzie et al, 1978). It also permits the learner to proceed at his own pace. Finally, reinforcement of learning in such situations is immediate and systematized, which again should result in more effective learning according to established theories of instruction.

Harrison (1993) found that students who received computer instruction showed greater increases in their achievement scores in multiplication and subtraction than students who received traditional mathematical instruction.

Most gender studies try to get at the reasons for males using the computer more than females. Collis and Ollila (1986) examined the gender differences in secondary school students' attitudes toward writing on the computer. Females were significantly less positive than their male counterparts on every item that related to computers.

Swadener and Hannafin (1987) studied the gender similarities and differences in sixth graders' attitudes toward the computer. They found that boys with higher achievement levels in mathematics also had high interest in computers. The boys with low scores had low interest in computers. This is the complete opposite of the females, with the low achieving female students having the most interest in the computers.

1.1 Statement of the Problem

This study was designed to see the relative effectiveness of computer-assisted instruction as a supplementing strategy on the academic achievement of secondary school students in the subject of science.

1.2 Objectives of the Study

The major objectives of the study were:

1. To find out the relative effects of computer-assisted instruction as supplementing strategy on the academic achievement in science.
2. To investigate the difference between treatment effects for male and female students.

1.3 Hypotheses

To achieve the objectives, of the study following null hypotheses were tested:

1. There is no significant difference between the mean scores of the students taught science with CAI as supplementing strategy and without CAI.
2. There is no significant difference between the mean scores of male and female students of experimental and control groups.

1.4 Delimitation of the Study

The study was delimited to:

1. See the effect of computer-assisted instruction as a supplementing strategy on the academic achievement of secondary school students in the subject of biology.
2. In the subject of biology, the topics covered during the experiment included: (1) Drugs, and (2) Microorganisms and Biotechnology.

1.5 Significance of the Study

The study is significant because its findings and conclusions may encourage the teachers to adopt computer-assisted instruction as an appropriate approach for instruction in regular classrooms; to induce the educational administrators and supervisors to promote computer-assisted instruction; and to provide a base for those interested in the educational development to plan and conduct further researches.

2. Procedure of the Study

The design found to be most useful for the purpose of this study was "The Post-test Only Equivalent Groups Design". In this design, subjects are randomly assigned to experimental and control groups. Following is the symbolic representation of the design:

R	E	=	T	O_1
R	C	=	-	O_2

Where R = Randomly selected
E = Experimental group

C	=	Control group
O	=	Observation or measurement
T	=	The experimental treatment to which a group is exposed i.e. independent variable.

This design is one of the most effective in minimizing the threats to experimental validity. At the conclusion of the experimental period the difference between the mean test scores of the experimental and control groups are subjected to a test of statistical significance, a t-test or an analysis of variance-ANOVA (Farooq, 2001).

The study was based on 'Operant Conditioning' theory of B. F. Skinner, where response leads to reinforcement and reinforcement influences the future response. Reinforcement may be pleasant or unpleasant, depending upon the nature of the response.

2.1 Sample

Since the software was available only in English language the students of 9th class of The City School, H-8, Islamabad (an English Medium School), were selected as sample of the study. Only students of science group studying biology as an elective subject were included in the sample. Sample students were divided into two groups, i.e. experimental group and control group. Both the groups were equated on the basis of their scores in previous semester in the subject of biology. Each group comprised 20 students.

Research Instrument

In order to secure data, a post-test was administered to the experimental as well as control group. A teacher-made test was given to the sample as post-test immediately after the treatment (teaching) was over. The purpose of this test was to measure the achievement of the students constituting the sample. The researcher made a thorough study of the biology units and the techniques of test construction. She, in consultation with the class teacher, constructed a test comprising multiple choice items, matching items, and items of short answers. These items were based on the selected biology units on (1) Drugs, and (2) Microorganisms and Biotechnology. These units were taught during the experiment to both experimental and control groups and were intended to measure the outcomes of learning. The test was administered to both groups.

2.2.1. Content validity.

This test was approved by the doctoral committee of the researcher. All the test items were based on the text of the unit taught to the sample students.

2.2.2 Reliability of test.

The split-half method (odd-even) was used to test the reliability of the post-test scores obtained by the students who formed the sample of the study. The coefficient of reliability was determined through the use of Spearman-Brown Prophecy formula, estimating reliability from the comparable halves of the post-test and it was found to be 0.73.

2.2.3 Previous achievement scores.

The data obtained from permanent school records were the scores of the sample in biology on the test given to the sample students at the end of previous semester. The scores were treated as previous achievement and were obtained to equate both the groups on the variable of previous achievement.

Data Collection

There were two different treatment patterns applied during the experiment. Both the groups were taught through routine method by the same teacher. The computer-assisted instruction (CAI) was used as supplementary strategy for the experimental group. During the experiment period, the experimental group received the treatment of the independent variable, i.e. computer-assisted instruction. The experimental group was also exposed to some websites consisting of drill and practice, tutorials, simulations, and animation.

The control group was kept busy in other activities such as guided practice and independent practice. The experiment continued for six weeks. The post-test was administered immediately after the treatment (teaching) was over. The purpose of this test was to measure the achievement of the students constituting the sample of the study. Final data were collected from 40 students – 20 from each group.

3. Analysis and Interpretation of Data

The achievement scores of the sample were obtained as a result of the post-test. Significance of difference between the mean scores of both the groups on the variable of previous achievement and scores on post-test was tested at .05 level by applying t-test.

To see the treatment effects for male and female students, the factorial design (2 X 2 analysis of variance) was applied. The factorial design is symbolized as below:

	Experimental	Control
Male	CELL 1	CELL 2
	CELL 3	CELL 4

Female

The significance of difference between the mean scores of experimental group and control group on previous achievement in biology was found out by applying a t-test. The summary of results is presented in Table 1.

Table 1: Significance of difference between the mean scores on previous achievement test of experimental group and control groups.

Group	N	df	Mean	SD	SE_D	t-value
Experimental	20	19	71.80	10.38	2.32	0.24 *
Control	20	19	71.25	10.31		

* Not significant t at 0.05 = 2.02

Table 1 indicates that the mean score of the previous achievement in biology of the experimental group was 71.80 and that of the control group was 71.25. The difference between the two means was not statistically significant at 0.05 level. Hence, both the groups could be treated as equal on the variable of previous achievement in biology.

Table 2: Significance of difference between the mean scores on previous achievement test of males and females of experimental group.

Group	N	df	Mean	SD	SE_D	t-value
Males	10	9	69.20	13.35	4.60	1.13*
Females	10	9	74.40	5.82		

* Not significant t at 0.05 = 2.10

Table 2 reflects that there was no significant difference between the mean scores on previous achievement of the males and females of experimental group. Hence, both male and female students included in experimental group could be treated as equal on previous achievement.

Table 3: Significance of difference between the mean scores on post-test of experimental group and control group.

Group	N	df	Mean	SD	SE_D	t-value
Experimental	20	19	78.40	9.11	2.99	2.14 *
Control	20	19	72.00	9.77		

* Significant at 0.05 level t at 0.05 = 2.02

It appears from Table 3 that difference between the mean score on the post-test of the experimental group was 78.40 and the same of the control group was 72.00. The difference between the two means was found significant at 0.05 level in favour of the experimental group.

Goode (1988) and Harrison (1993) also found that students who received computer instruction showed greater increases in their achievement scores.

Table 4: Significance of difference between the mean scores on post-test of males and females of experimental group.

Group	N	Df	Mean	SD	SE_D	t-value
Males	10	9	75.70	11.84	3.98	1.36*
Females	10	9	81.10	4.33		

* Not significant t at 0.05 = 2.10

It is clear from Table 4 that the difference between the mean scores on post test of males and females of experimental group was not significant at 0.05 level. Hence, both males and females of the experimental group performed equally on the post-test

These findings support Sacks et al. (1994) who found that there were no overall gender differences in actual use of the computer nor did computer use increase across the course of the study.

Table 5: ANOVA (2 X 2) showing difference between mean scores on post-test of males and females of experimental and control groups.

Source of variance	Degree of freedom	Sum of squares	Mean square Variation	F
Treatment	1	409.60	409.60	20.89*
Gender	1	360.00	360.00	18.37***
Interaction	1	2323.20	2323.20	118.53***
Within cells	36	705.60	19.60	

* Significant F at 0.05 level = 4.12
** Significant
*** Significant

Table 5 indicates that the F-value obtained in case of "treatment" as the source of variation and "gender" as source of variation was significant at 0.05 level. The interaction between treatment and gender was also significant at 0.05 level.

3.1 Discussion

Both the experimental and control groups were compared on the variable of previous achievement. The results obtained from the statistical analysis showed that no significant difference existed between the two groups with respect to previous achievement in biology, as t-value obtained was not statistically significant at 0.05 level (Table 1). Hence both the groups could be treated as equal.

H_O: 1. The performance of the experimental group was significantly better than that of the control group on post-test. The difference between the two means was statistically significant at 0.05 level (Table 3). Thus, the null hypothesis that, "there is no significant difference between the mean scores of the students taught science with CAI as supplementing strategy and without CAI", was rejected at 0.05 level in favour of the experimental group. These findings support the findings of the studies conducted by Goode (1988) and Harrison (1993).

H_O: 2. The F-value obtained in case of "treatment" as the source of variation and "gender" as source of variation was found to be significant at 0.05 level. The interaction between treatment and gender was also significant at 0.05 level (Table 5). Thus, the null hypothesis that, "there is no significant difference between the mean scores of male and female students of experimental and control groups", is rejected at 0.05 level. These findings support the findings of the study conducted by Sacks et al. (1994).

The above results revealed that both the null hypotheses were rejected. It means that performance of experimental group was significantly better than that of control group on post-test on the variables of overall achievement, gender and achievement level of the students.

To make it clear whether the experimental treatment was more effective for the males or females, Table 4 is referred here where mean score of the female group on post-test was found to be 81.10 as compared to 75.70, that of male group and it was found below the level of significance. It was found significant when interaction between treatment and gender was calculated (Table 5). Therefore, it can be concluded that the performance of females on post-test was significantly better than that of males.

The overall results of the study indicate that CAI, as a back up strategy to support traditional teaching methods, improved students' achievement in the subject of biology at secondary level with higher achievement gains. Since software in the subject of biology at secondary level (CDs and websites) were available only in English language, the results of the study, therefore, can be generalized only to English medium schools.

4. Conclusions

On the basis of statistical analysis and the findings of the study, the following conclusions were drawn:

1. The application of computer-assisted instruction as supplementary strategy in teaching of biology was found to be more effective.
2. Though computer-assisted instruction as supplementary strategy was found to be equally effective for male and female students, yet the female students benefited more from computer-assisted instruction as compared to male students.

5. Recommendations

In the light of the findings revealed and conclusions drawn from the study, the following recommendations are made:

1. An experiment with the students from different cultural backgrounds such as urban and rural areas is needed to examine the effectiveness of computer-assisted instruction as a supplementary strategy.
2. An experiment with greater number of students from different secondary schools, representing a wider range of intelligence, be planned to examine the results of this study.
3. The present study was conducted to see the effect of computer-assisted instruction as supplementary strategy in teaching of biology. Such studies are needed to be planned and conducted in other subject areas such as mathematics and social sciences.
4. Since no software was available in Urdu language for the teaching of biology, the experiment was conducted in an English Medium School. The Software Companies be approached for the development of software in Urdu language for different subject areas. In such case, the students from rural areas can also benefit from computer technology.

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