The Influence of Computer Assisted Instruction (CAI) in Chemistry on the Students Achievement at Higher Secondary Level

By

Muzammila Akram[1], Hafiz Muhammad Athar[1] and Murad Ali[2]

[1]Lecturer Department of Educational Training, The Islamia University of Bahawalpur, Pakistan.

[2]Lecturer Department of Chemistry, Government College of Technology Bahawalpur, Pakistan.

Abstract

Instructing chemistry requires Teachers to relate chemical equations and other symbolic notations both to molecular or atomic events and to laboratory observation and data. Traditionally, text books of Chemistry have symbolic notations with minimal pictures leaving the teacher and students to invoke these pictures from words. This paper was designed to find out the influence of computer assisted instruction on the student's achievement in chemistry and to compare the effectiveness of CAI with conventional instruction at higher secondary school level. Null hypotheses were formulated on the basis of objectives and to test the hypotheses, two experiments of one month duration were conducted in both government and private sectors of Bahawalpur City. The pre-test, post-test control group design was developed for the current study. The achievements of forty (40) students were recorded through pre-test and then students were divided randomly into two groups of twenty (20) in each group. Groups were assigned as control group and experimental group randomly. Ten topics out of the prescribed textbooks of chemistry for class XI were taught, keeping in view that the students had never studied these topics before. The control group was instructed by the lecture while the experimental group was instructed through CAI, under the same conditions. The data obtained through experimentation, was analyzed using statistical methods of mean score and t-test for independent sample. The findings indicated that there was significant influence of CAI on the student's achievement in both, government and private sectors. However, CAI influence was found to be more significant in private school than government school. Computer-assisted instruction in teaching chemistry proved better than the conventional instruction.

Keywords: Computer Assisted Instruction; Conventional Instruction; Student's Achievement; Chemistry Education; Higher secondary level; Government and Private schools.

Introduction

The first pioneering attempt in CAI was made in the USA in 1961 when the University of Illinois produced Programmed Logic for Automatic Training Operations (PLATO). The second land mark in CAI was in the year 1966 when computerized tutorials in Arithmetic and Reading for elementary school children were developed by Patrick Suppes of Stawford University. Now the Computer Assisted Instruction (CAI) has become an integral part of the learning process in the advanced and developed countries of the world (Aggarwal, 1995, p.361).

Computer systems can deliver instruction directly to students by allowing them to interact

with lessons programmed into the system; this is referred to as Computer Assisted Instruction (CAI).It is used to describe the use of computers for instructional tasks (Russell, 1990, p.356). In CAI, the students interact directly with the computer system which stores the instructional material and controls its sequence. CAI is used when a computer is a teaching aid, a proxy for a human tutor. CAI software is purchased as a package or written by the classroom teacher. The programs present subject material on a CRT screen. Then students are tested by the program on their mastery of the material. Correct answers are rewarded, usually by means of a comment on the screen such as "well done". Incorrect responses trigger a beep or some other error signal (Wells, 1992, p.168). Programs for CAI can be written in a variety of modes such as; Tutorial, Drill & Practice, Gaming, Simulation, Discovery and Problem-solving. A comprehensive picture of different modes of CAI is presented below.

Methods	Description	Role of Teacher	Role of Computer	Role of Student	Applications/Examples
Drill-and-Practice	Content already Taught Review basic facts And terminology Variety of questions In varied formats Question/answer Drills repeated as necessary	Arranges for prior Instruction Selects material Matches drill to student Checks progress	Asks questions "Evaluates" student Response Provides immediate Feedback Records student Progress	Practices content Already taught Responds to questions Receives confirmation And/or correction Chooses content and difficulty level	Parts of a microscope Completing balance Sheets Vocabulary building Math facts Product knowledge
Tutorial	Presentation of new Information Teaches concepts And principles Provides remedial Instruction	Selects material Adapts instruction Monitors	Presents information Asks questions Monitors responses Provides remedial Feedback Summarizes key Keeps records	Interacts with computer Sees results Answers questions Asks questions	Clerical training Bank teller training Science Medical procedures Bible study
Gaming	Competitive Drill-and-practice in A motivational Format Individual or small Group	Sets limits Directs process Monitors results	Acts as competitor Judge Scorekeeper	Learns facts/strategies/ Skills Evaluates choices Competes with Computers	Fraction games Counting games spelling games Typing (arcade-type) Games

Simulation	Approximates real- Life situations Based upon realistic models Individual or small Group	Introduces subject Presents background Guides "debriefing"	Plays role (s) Delivers results of decisions Maintains the model and its database	Practices decision making Makes choices Receives results of decisions Evaluates decisions	Troubleshooting History Medical diagnosis Simulators (pilot/driver) Business management Laboratory experiments
Discovery	Inquiry into database Inductive approach Trial and error Tests hypotheses	Presents basic problem Monitors student Progress	Presents student With source of Information Stores data Permits search Procedures	Makes hypotheses Tests guesses Develops principles/rules	Social science Science Food-intake analysis Career choices
Problem Solving	Works with data Systematizes information Performs rapid and accurate calculations	Assigns problems Checks results	Presents problem Manipulates data Maintains database Provides feedback	Defines the problem Sets up the solution Manipulates variables	Business Creativity Troubleshooting Mathematics Computer programming

Note: From "Instructional Media" by Heinich, and others, 1996, p.360.

Studies found that Computer Assisted Instruction (CAI) enables students to be more active learners than the traditional lecture method.

Inci, Soner, Ozge & Seçil (2005) worked together on the Computer-assisted learning in teaching acids & bases and published their research article in the journal. They compared traditional and the computer-assisted methods by instructing a fundamental topic of acids & bases in chemistry. Moreover the effect of the computational attitudes, three dimensional spatial visualization abilities, and learning styles of the students were investigated. The students were distributed randomly into control and experimental groups and their knowledge about acids and bases was assessed by a test comprising of 20 questions. After this test, the experimental group received computer-assisted instruction and the control group received traditional instruction for two days on the related subject. After two days of teaching, the students were re-tested with the same twenty questions. Parallel to this, computational attitudes, the three-dimensional spatial visualization abilities, and learning styles of the students from both groups were assessed. The computational attitudes, three dimensional spatial visualization abilities, and learning styles of the students were not found to affect their test scores. However, a 52% improvement was observed in the post test results of the students of the experimental group and 31% improvement was observed in the pot test result of the students of the control group. Thus a significant difference was found favouring the

computer-assisted instruction.

Another study was conducted by Jackson (1988) which was designed to investigate the effects of the computer on attitudes, motivation, and the possible advantages of computer-assisted test programs. This study was conducted on secondary school students who were assessed by pre-test then they were distributed into control and experimental groups. The assessment of the experimental group was done with the help of computers, whereas the control group was done through a written test. The statistical evaluations showed a higher achievement rate for the experimental group that received a computer-assisted test.

Levine & Schmidt (1996) compared the conventional learning strategies with computer-based activities. The pre-test, post-test control group design was developed for the study. The students were distributed into control and experimental groups. The results of the evaluations showed that the students of experimental group proved better in answering the questions of the Chemistry Achievement Test.

Yildrim, Ozden & Aksu (2001) worked on hypermedia learning environments on the chosen subjects and compared it with traditional learning. Forty-nine students of 9th grade biology were distributed into subject (hypermedia learning environment) and control (traditional) groups. Pre -post-tests and retention tests were administered to both the groups. The results of the post-test did not show a significant difference between the control and experimental groups about acquiring knowledge. However, the retention tests indicated that the students of experimental group retained knowledge better than the students of control group.

Rivers & Vockell (2007) investigated the problem solving skills of high school biology students by using computer simulations. Simulations were administered to the students of experimental group with and without guidance, whereas control group was not administered by the simulation. The student's performance was assessed by post-tests, scientific thinking tests and critical thinking tests. The results showed that the students who were guided through simulations could achieve better in results of the post-tests, scientific and critical thinking tests.

Inspite of the unprecedented impact of CAI on education in advanced countries; it has not made much headway in Pakistan. On account of several reasons, Pakistan has not been able to introduce the CAI on a substantial scale. In fact, computers in education are hardly used by the teachers as far as their classroom instructional work is concerned. CAI must be tried out in selected areas of instruction in the first instance. It appears in the near future, as the situation is, there are remote possibilities of the use of this new medium of classroom communication on an appreciable scale, in the educational institutions. Resource crunch and overcrowded classes seems to be the greatest hurdle in this context. Moreover educational institutions are in general lack of suitable facilities and basic equipment. The introduction of computers in education is not quick and easy path to follow. But to be at par with the developed countries it can be hardly afforded to ignore its importance in education, a more comprehensive plan is needed to be developed to give the practical knowledge of basic skills to operate the equipment, ability to design and prepare software, etc., to the maximum number of teachers.

The aim of this study is to identify the any possible differences in the student's achievement when the subject of chemistry is taught using CAI or the traditional methods in government and private schools.

Null Hypotheses

The following null hypotheses were formulated for the study:

H_o 1: There is no significant influence of CAI on student's achievement in chemistry at higher secondary level in government school.

H_o 2: There is no significant influence of CAI on student's achievement in chemistry at higher secondary level in private school.

H_o 3: There is no significant difference in the mean achievement of control and Experiment Groups in Post-test of government school.

H_o 4: There is no significant difference in the mean achievement of control and Experiment Groups in Post-test of private school.

Method

The pre-test, post-test control group design was developed for the current study.

The subjects

Subjects for this study were XI class chemistry students in Dominican convent Girls Higher Secondary school (Private), Bahawalpur. All students (i.e. 40) were selected for the study.

In Government sector, subjects for this study were selected randomly from population of two hundred students of Government Higher secondary school for Women, Bahawalpur. Systemic random sampling technique was adopted. Same numbers of chemistry XI students were randomly selected by using the list of the randomly ordered population of two hundred (200) students. The sample size was 40, thus the value of K became 5. Every 5th name on the list was randomly selected and randomly assigned in two groups.

The test instrument

The data of the study was collected through the following tests and applications.

The computer software

As it is an experimented research, the standardized software packages on selected topics of chemistry were used for the purpose of the study. The software that was used in the computer-assisted instruction is the CCI Project software programme (creative chemistry on the Web) prepared by ETH (Eidgenossiche Technische Hochschule Zurich / Switzerland). The software is available through the internet (CCI – Project (creative chemistry on the internet) by ETH (Zurich; http://www.cci.ethz.ch). The software includes some experiments on the subject of concepts. Moreover, GCSE Chemistry computer software and DK Chemistry CD were also

used during experiment.

Chemistry achievement test

The chemistry achievement test (pre, post-test) was developed on the selected topics of chemistry by consulting the eminent chemistry teachers and according to the CCI project and GCSE software packages keeping in view the objectives of the study. Ten Topics of chemistry were selected for the test, keeping in view that students had never been taught these topics before, not a single concept was even included in the chemistry syllabus of secondary level

These topics were Collision theory, Rate of reaction, Order of reaction, Effect of temperature, Effect of catalyst, Dynamic nature of Equilibria, Equilibrium constant, Acid Base reaction, Bronsted – Lowry theory, Buffer solutions. The chemistry achievement test consisted of 50 questions in all, 30 MCQ's and 20 short answers. Three MCQ's and two short answers were constructed from each ten topics of chemistry for the achievement test. Each item carried one mark, so the total marks of test were 50. After marking the papers, numbers out of 50 were converted into percentage.

Reliability and validity of the instrument

To maintain the validity, the standardized software packages were selected, keeping in view the objectives of the study, and the opinions of specialists were sought in order to determine which concepts were to be asked in the test. After the experts views were taken into consideration, the inner validity of the chemistry achievement test was achieved.

To maintain the reliability, the international standardized computer software i.e. CCI-Project software package, GCSE software packages and DK learning software on the selected topics of chemistry were used.

The test administration and procedure of the study

Prior to the beginning of the school year, forty, XI-Chemistry students were selected randomly by using the table of random numbers from a population of approximately 200, in Government Higher secondary school for Women, Bahawalpur. Forty (40) number of students were selected because same no of students were experimented in private sector (Convent Higher SEC. School) where total population was forty. One group was randomly designated to be experimental group.

To test the hypotheses, two separate experiments of one month duration were conducted in both government and private schools. The pre-test, post-test control Groups Design was developed for the current study. The forty (40) student's achievement was recorded through pre-test and then the students were divided into two groups randomly of twenty (20) each; groups thus constituted was kept equivalent on the basis of pre-test scores. One group was declared as the experimental group randomly. Pre-test of both the groups were taken before conducting the experiment. The experiment was concerned with teaching of chemistry through CAI. Ten topics out of the prescribed textbooks of chemistry for class XI were taught,

keeping in view that the students had never studied these topics before. The topics were instructed to the experimental group and control group under the same conditions. The control group was instructed by the lecture while the experimental group was instructed through computer assistance. When the experimental treatment was over i.e. after one month, the post-test was conducted on the both groups.

The period of chemistry was of equal duration i.e. 35 minutes for both groups. Both groups covered the same subject matter and used the same text. Both groups were instructed by the same teacher i.e. researcher.

Data analysis

The data obtained from pre-test and post-test were analyzed statistically. In this study the t-test for independent samples was used to determine whether two means were significantly different at a selected probability level. 0.01 level was taken as the level of the significance to reject the null hypothesis. Mean scores were also compared. All the data was entered in computer. SPSS-11 was used for the analysis of data.

Results

The results were displayed in following tables.

Table 1. Independent Samples t-test for government school students

	Levene's Test for Equality of Variances F	Sig.	t-test for t-test for Equality of Means t	Sig.(2-tailed)	df.	Mean Difference	Std. error diff
Gain Scores government (post test - pre test of control and experimental groups)	8.613	0.006	-8.346	0.000	38	-9.10	1.09

Table 1 was about the Ho1 i.e. there is no significant influence of CAI on student's achievement in chemistry at higher secondary level in government school. This table shows the result of independent sample t-test for government schools. Its value – 8.346 is significant at $\alpha = 0.01$ level. So Ho1 was rejected.

Table 2. Independent Samples t-test for private school students

	Levene's Test for Equality of Variances F	Sig.	t-test for Equality of Means t	Sig.(2-tailed)	df.	Mean Difference	Std. Error Difference
Gain Scores private (post test - pre test of control and experimental groups)	47.770	0.000	-8.378	0.000	38	-18.20	2.17

Table 2 was concerned with Ho2 i.e. there is no significant influence of CAI on student's achievement in chemistry at higher secondary level in private school. This Table indicates the result of independent sample t-test for private schools. Its value – 8.378 is significant at α = 0.01 level. So Ho 2 was rejected.

Table 3. Mean scores of government school Students in post-test

Group		Marks in post test government
Control Group	Mean	36.40
	Std. Deviation	5.491
Experimental Group	Mean	45.50
	Std. Deviation	5.267

Table 3 was about H_o3 i.e. there is no significant difference in the mean achievement of control and Experiment Groups in Post-test government sector school. This table showed that mean scores of post tests of control group and experimental group of government schools were 36.40 and 45.50 respectively. So H_o3 was rejected.

Table 4. Mean scores of Private school Students in post-test

Group		Marks in post test private
Control Group	Mean	58.90
	Std. Deviation	12.422
Experimental Group	Mean	77.20
	Std. Deviation	5.444

Table 4was about H_o4 i.e. there were no significant difference in the mean achievement of control and Experiment Groups in Post-test private school. This table indicates that Mean scores of experimental groups (i.e.77.20) private schools was higher than the mean scores of its relative control groups. So H_o4 was rejected.

Table 5.Comparison of the mean scores in the Post-test of Govt. & Private School

Group	Mean Score in post test government	Mean Score in post test private
Control Group	36.40	58.90
Experimental Group	45.50	77.20

Table 5 compares the mean scores in the Post-test of control groups i.e. 36.40 in government school and 58.90 in the Private school. This table also compares the mean sores in Post-test of experimental groups i.e. 45.50 in government school and 77.20 in the private school.

Conclusions and Discussion

There was significant influence of CAI on student's achievement in chemistry at higher secondary level in government school.

There was significant influence of CAI on student's achievement in chemistry at higher secondary level in private sector also.\

Students who were taught through CAI showed better result in the Post-test in both government and private schools. Hence, it was recommended that chemistry teachers might use CAI in their classes.
Students who were taught through conventional instruction i.e. lecture method, showed less improvement in the Post-tests in both government and private schools.

The Mean scores of Post-tests of control and the experimental groups in private school were higher than the mean scores of Post-tests of control and experimental groups in the Govt. School.

Private school students showed better result in pre-test and post-test of control and experimental groups than government school students. It may be due to medium of instruction i.e. English in private schools, throughout the classes, and they faced less difficulty in using CAI as all computer software of chemistry were programmed in English, especially in using tutorial mode, where tutor's sound and English accent was familiar to English medium students. While most of government students, passed their matriculation exams in Urdu and

change in medium of instruction caused more difficulty in understanding the concepts of chemistry in English. More researches need to explore this problem.

Computer-assisted instruction in teaching chemistry proved better than the conventional instruction as it significantly improved student's achievement in government and private sectors. The influence of CAI on the student's achievement has also been supported by previous researches (Ranade, 2000; yildrim, 2001; Morgil & others, 2003; park, 2006). However, private schools students showed better achievement than govt. school students (Table 5).This study was confined to the influence of CAI on the student's achievement in chemistry, which was fully justified by true experimental research. It opens a new horizon for new researchers to investigate the variables, like computer user and non-user, educational and economical status of parents, medium of instruction and computational attitudes etc, which may affect the CAI.

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