

Effectiveness of Computer Assisted Instruction in Teaching-Learning Process of Mathematics at College Level: An Experimental Study

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Abstract: The present study aimed at investigating the effectiveness of computer assisted instruction (CAI) as an approach of teaching and learning of Mathematics. Mathematics has been considered a significant subject in all the curricula right from primary to tertiary levels. But, mathematics has been projected as the most dreadful and dry subject. In this experimental study, the investigators tried to prove that mathematics can be learnt by all students at any level ensuring the mastery over it. The investigators carried out an experiment of selecting a sample of 30 B.Sc. first year students of mathematics and dividing these students into two equal groups designating as an experimental group of (CAI) and control group (CMT). For the completion of the study, pre-test and post-test experimental design was adopted and the experiment proved that CAI remained as an effective approach of imparting instruction in the classroom concerning to Mathematics course content as compared to conventional method of teaching of Mathematics tertiary level.

Key-terms: Effectiveness, Computer Assisted Instruction, Experimental Group, Control Group, Conventional Method of teaching tertiary level.

Introduction: Mathematics plays a vital role in understanding the whole gamut of knowledge and making use of it in practices. Mathematics is considered as the mother of all sciences. Further, it needs to be understood that mathematics is not only required to be an engineer or technocrat, but it is essentially required to be a good and productive member of the society. It is the mathematics which ensures the concept of better world around us. In view of this, Mathematics has been considered utmost significant subject of learning at different levels across the world. Choudhary (2014) opined on mathematics as the entry to all sciences. But, in spite of all these facts and explanations about the need and significance of mathematics as the discipline of learning Mathematics has been projected as the most dreadful and dry subject. It is because of this, the students do have some fear, anxiety, tension, depression by the name of Mathematics. Now the question arises, who has created this negativity about the nature of mathematics? Further, it has also been established that mathematics and science subjects are only meant for brilliant students of the society. But, B.S. Bloom (1971) claims that 95% students can attain mastery over the learning tasks, if they are given sufficient time and appropriate support. Mastery learning is an optimistic theory of teaching and learning. In case all the assumptions of mastery learning strategies are followed and teacher can make the “Dumb” students to learn like that “Smart” students, the “Slow” students learn like the “Fast” students, “Retarded” students learn like the “Gifted” students. In fact, it was John B. Carroll (1963) who was deadly against the notion that students are to fail in any of the subject rather he was of the opinion that all will learn. Basically, it was Carroll who propounded the concept of Mastery learning and B.S. Bloom (1971) carried out further the concept given by Carroll for making the students to learn at mastery level, Bloom came out with some assumptions such as:

- The subject matter is analyzed and divided with its elements. Each element may be presented independently with proper sequence.
- The presentation of subject matter needs to be in small steps and logical order.
- For the effective presentation, all the required software and hardware materials need to be used effectively.
- The students are expected to learn at their individual level in accordance with their pace of learning.
- The students need to be tested unit after unit continuously and comprehensively with the involvement of formative evaluation.
- The students need to be provided feedback and reinforcement unit after unit by looking into all the instructional objectives.
- It works on the assumption that 100% students of the class are expected to learn 100% course context of the unit/units at the end of the course summative criterion test is administrated to ensure 100/100 criterion.
- It is assumed that every student can learn the course context at mastery level.
- It makes the system objective cum outcome based in nature.
- It works on the assumption of ensuring all the three levels of learning i.e., memory, understanding and reflective levels of learning.

In view of these assumptions, Bloom's mastery learning strategy (BMLS) was experimented and became popular across the western world. Romberg, Shepler, and King (1970) came out with a conclusion that the students taught through BMLS indicated better performance as compared to the students taught through other non-mastery teaching strategy. Similar results were brought out by Kersh (1971), Wentling (1973), Anderson (1976), Koundal (1981), Kapoor K.C. (1986), Kapoor K.C. (1989), Kaul & Chand (1985), Zemira (1985) etc. investigated the effect of students-teams using mastery learning strategies on the learning of mathematics and showed higher performance in mathematics than the students taught through non-mastery strategy. On the pattern of BMLS and its assumptions, several other scholars came out with some new and modern approaches of teaching and learning under the scope of instructional technology such as Programmed Instruction (PI), PSI (Fred S. Keller, 1963), Modular Instruction (MI), Computer Assisted Instruction (CAI) came out in a big way specially in the beginning of 21st century. Looking back into the history of computer assisted instruction, it was attempted in the year 1961 for the first time in USA when the university of Illinois produced the programmed logic for automatic teaching operation (PLATO). After this, as we entered into the 21st century which is century of 'Knowledge Explosion' and 'Population Explosion; Information and Communication Technology (ICT) has emerged in a big way across the world. There has been a boom in the use of computers in every walk of life. Implications of technology in education have been observed greatly. The whole system of imparting instructions in classroom got revolutionized due to the use of computers. NPE-1986, POA-1992, NCFSE-2005, and NEP-2020 have emphasised on the technological input for the enhancement of quantitative and qualitative improvements in the field of education. There are several studies which have conducted at the national and international level concerning to an effectiveness of computer assisted instruction in the teaching and learning of mathematics.

A new instructional model was tried out by Warner's and Kaur Abtar (2017) which was popularly designated as 2T2C model. In this study, the investigators adopted qualitative research design and the teachers indicated better and higher order thinking in relation to understand the course content of Mathematics. The teachers admitted that approach to facilitating mathematics concepts using 2T2C model was in stark contrast to what they were accustomed. The students learnt the mathematical concepts without any anxiety uncomfortability.

In the Indian context CAI may be considered a recent phenomenon. Computer was not used in mass scale before the beginning of 21st century in India. But after 2000 the use of computers has been marked tremendously in everyfield specially in the field of education. There are large number of studies on the effectiveness of CAI as an approach of teaching which several Indian and western scholars conducted. Hess and Tenezakis (1973) found that the group of students who were taught Arithmetic through CAI, they showed their favourable and positive attitude towards the learning of Arithmetic as compared to the students of conventional method of learning. Singh et.al. (1991) carried out an experimental study aiming at investigating the effectiveness of CAI in the process of teaching and learning of mathematics. The study proved that the student's CAI group performed better in mathematics than the students of conventional method of teaching. Similarly, some of other research studies are conducted on the effectiveness of CAI such as Khan (1998), Patel (2008), Vasanthi &Hema (2003), Barrow et.al. (2009), Tolbert (2015). The review of related research studies revealed that the computer assisted instruction (CAI) as an instructional strategy has been found very effective in teaching and learning of Biology, Chemistry, etc. at school stage. But, only a few numbers of studies have been marked on the effectiveness of CAI in teaching and learning process of Mathematics specially at college level. Therefore, the investigators thought appropriately to take up the following experimental study in hand:

Statement of the research problem:

"Effectiveness of Computer Assisted Instruction in Teaching- Learning Process of Mathematics at College Level: An experimental study".

Objectives of the study: The investigators formulated the following objectives of the present study-

1. To investigate the effectiveness of CAI on the achievements of college going two groups of students in the learning of mathematics: one following CAI and another following conventional method of learning.
2. To find out the attitude of college going B.Sc. first year students towards CAI as an instructional approach in teaching and learning of the concepts of matrices as the segment of mathematics

Hypotheses of the study:

1. There will be no significant difference between the academic achievement mean scores of two groups of B.Sc. first year college going students in Mathematics on summative criterion test: one following CAI and another following conventional method of teaching.
2. There will be no significant difference between the attitude mean scores of male and female B.Sc. first year college going students towards CAI as an approach of imparting instructions in the classroom for teaching and learning of mathematics.

Delimitations of the study: The present study has been delimited to-

1. B.Sc. first year college going students of Mathematics
2. CAI as an approach of imparting instructions on mathematical course content

3. Course content of matrices as a segment of Mathematics

Methodology:

As per the nature of research problem, the investigators adopted experimental method of research with pre-test and post-test research design. Academic achievement of students in the concept of matrices as the segment of mathematics was considered dependent variable whereas CAI and conventional method of teaching mathematics were taken as independent variables in the experiment. The population of the study was B.Sc. first year students of the college, out of this population a sample of 30 students was drawn by making use of random sampling technique and the selected sample of 30 students was divided into two groups:

- (i) Experimental Group with 15 number of students.
- (ii) Control group with another 15 number of students.

Both the groups were matched properly on the basis of their previous academic achievement score of 10+2 level.

Tools used: For the completion of this experimental study, the investigators used the following tools:

- (i) Instructional material was developed on matrix as the segment of mathematics for B.Sc. first year college going students.
- (ii) Summative criterion test.
- (iii) Attitude scale to measure the attitude of students towards CAI

It is significant to mark that all the above stated instructional material and tools were developed and standardised by the investigators.

The whole experiment was completed in the following phases:

Phases of Experiment: Experiment was completed in three phases that are described as under:

Phase-I: This was the first phase of the experiment under which the instructional material on the concepts of matrices was developed in accordance with the instructional objectives. Second for each unit and subunits formative tests were developed and third the summative criterion test was constructed and standardised. Now the sample was divided into two equivalent groups and designated as experimental group and conventional group. the summative criterion test was administered to obtain the Pre-Test scores of the subjects of experimental and control groups. The obtained pre-scores were denoted as X_1 and X_2 in relation to experimental and control groups respectively.

Phase-II: After obtaining the pre-test scores, the instructional materials were exposed to the experimental group through CAI, an approach of imparting instructions on the concept of matrices. After the completion of each unit and sub-units of the course content, formative testing was done. On other hand, the students control group were taught through the conventional method of teaching.

Phase-III: At the end of the experiment, the summative criterion test was administered on the students of experimental group and control group for obtaining the post-test scores denoted as Y_1 and Y_2 for experimental and control groups of students respectively. Secondly, at the end of the experiment, attitude scale was also administered on the students of experimental group only to measure their attitude toward CAI as an approach of imparting instruction for the teaching the concepts of matter as the segment of mathematics

Analysis and Interpretation of Results: For analysing the collected data, the investigators used Analysis of Co-variance (ANCOVA) as the statistical technique. All the assumptions like the assumption of normality, randomization, homogeneity, etc. were taken care for the purpose.

Objective-1: To investigate the effectiveness of CAI on the achievement of college going two groups of students in the learning of mathematics: one following CAI and another following conventional method of learning.

Hypothesis-1: There will be no significant difference between the academic achievement of mean scores of two groups of B.Sc. first year college going students in Mathematics on summative criterion test: one following CAI and another following conventional method of teaching.

The summary of the computed results of ANCOVA pertaining to Computer Assisted Instruction (CAI) and conventional method of teaching (CMT) groups of students has been put in table-1

Table-1: Summary of the results of ANCOVA relating to CAI and CMT groups of B.Sc. first year students of mathematics.

Components of variability	Sum of squares	df	Variance(v)	F-value
Between samples(D)	905.49	C-1 2-1=1	905.49	637.66
With a sample error (E_w)	38.49	N-C-1 30-2-1=27	1.42	
Total (E_t)	943.98	N_1+N_2-2 15+15-2=28		

The adjusted mean of summative criterion test scores of first group (CAI)

$$M_{Y_1X_1} = M_{Y_1} - b(M_{X_1} - G_{M_X})$$

The adjusted mean of summative criterion test scores of second group (CMT)

$$M_{Y_2X_2} = M_{Y_2} - b(M_{X_2} - G_{M_X})$$

M_{Y_1} and M_{Y_2} are the means of summative criterion test (post test scores).

G_{M_X} is the grand mean of pre-test scores on the summative criterion test obtained by the students of two groups.

b is the regression coefficient which is:

$$b = \frac{\sum XY - \frac{(\sum X)(\sum Y)}{N}}{\sum X^2 - \frac{(\sum X)^2}{N}} = \frac{16007 - \frac{(549)(870)}{30}}{10129 - \frac{(549)^2}{30}} = 1.02$$

$$G_{M_X} = \frac{M_{X_1} + M_{X_2}}{2} = \frac{18.4 + 18.2}{2} = 18.3$$

$$M_{Y_1X_1} = M_{Y_1} - b(M_{X_1} - G_{M_X})$$

$$= 34.6 - 1.02(18.4 - 18.3)$$

$$= 34.498$$

$$M_{Y_2X_2} = M_{Y_2} - b(M_{X_2} - G_{M_X})$$

$$= 23.4 - 1.02(18.2 - 18.3)$$

$$= 23.502$$

Summary of results has been shown in the table-2

Table-2: Showing the means of pre-test and post-test scores of summative criterion test of CAI and CMT groups of students of Mathematics

Groups	N	M_Y	M_X	Adjusted means
CAI (Experimental group)	15	34.6	18.4	34.498
CMT (Control group)	15	23.4	18.2	23.502
$G_{M_X} = 18.3$				

Interpretation: The Table-2 indicates that the computed F- value came out to be 637.66 which is greater than the criterion F-value (7.68) at .01 level of significance 1/27 df. As the computed F-value (637.66) has been found greater than the table value, hence, the computed F-value (637.66) considered significant and the formulated hypothesis “there will be no significant difference between the academic achievement mean scores of two groups of B.Sc. first year college going students on summative criterion test: one following CAI and another following conventional method of teaching got rejected”. From this, it is interpreted that there is significant difference between the academic performance of CAI group and CMT group of students in the learning of concepts of matrices as a segment of mathematics. Further, it is also understood that the computer assisted instruction in teaching-learning process of mathematics proved to be more effective as compared to learning of mathematics segments through conventional method of teaching. The finding of the present study also supported by some of the other research studies like Vasanti & Hema(2023), Dange(2013), Parmar(2013), Serven(2011), Dickson(2018). It means that the concepts of Mathematics are really possible to be learnt at mastery level by all categories of students provided the mathematical course content is presented through some modern approaches of teaching with some patience in small and logical order by involving the mechanism of formative testing.

Objective-2: To find out the attitude of college going B.Sc. first year students towards CAI as an instructional approach in teaching and learning of the concepts matrices as the segment of mathematics.

Hypothesis-2: There will be no significant difference between the attitude mean score of male and female B.Sc. first year college going students towards CAI as an approach of imparting instructions in the classroom for teaching and learning of mathematics.

For achieving the objective-2 and testing its hypothesis, the collected data pertaining to attitude of students towards CAI have been put in table-3 and table-4.

Table-3: Frequency table showing the attitude scores of B.Sc. first year college going students towards CAI as an instructional approach of teaching and learning mathematics.

Class intervals	35-49	40-44	45-49	50-54	55-59	60-64
Frequencies	1	0	1	3	6	4

Mean=55.33 (86.45%), Median=57.0 (89.06%), Mode=57.5 (89.84%)

Table-4: Showing the means, SDs, SE_D, and computed t-value of attitude score of male and female B.Sc. first year students of Mathematics

Groups	N	M	σ	SE _D	t-value
males	12	56.16	3.17	3.69	1.57
females	3	50.34	6.21		

Interpretation: Table-4 reveals that computed attitude mean score of the experimental group of students came out to be 55.83(86.45%) out of the 64-maximum score of attitude scale. The computed attitude seems to be quite higher and it speaks that the B.Sc. first year students of Mathematics liked the CAI as an approach of teaching and learning Mathematics. The students found themselves very comfortable in the process of learning of mathematics due to the use of CAI, hence, they are of the opinion that CAI needs to be used regularly in the teaching of mathematics at school level, college level and university levels. Second, the attitude score of male and female students were taken and compared by computing the t-value as shown in table-4. The computed t-value came out to be 1.57 which is lesser than the table t-value (2.16) at .05 level of significance for 13 df, hence, formulated hypothesis: “there will be no significant difference between the attitude mean score of male and female B.Sc. first year college going students towards CAI as an approach of imparting instructions in the classroom for teaching and learning of mathematics got rejected”. From this, it interpreted that the male and female students did not differ in their attitude mean scores and both male and female students do possess equally high and favourable attitude towards CAI as an approach of learning mathematics.

Conclusion: Finally, it is concluded that the CAI as an instructional approach has been found very effective in the process of teaching and learning of the course content of mathematics. This is the approach of teaching which makes the teaching-learning process outcome based in the nature and students learn the mathematics subject at mastery level with out any inconvenience. It is new and modern instructional strategy which removes the fear and anxiety from the minds of learners concerning the learning of mathematics. Students do have favourable attitude towards CAI as learning of mathematics.

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