Development and Effectiveness of Computer-Assisted Instruction (CAI) on the Academic Achievement in Mathematics for Class IX Students

DR. MUNNI KUMARI
Assistant Professor
Shiv College of Education
Tigaon Faridabad

Abstract:

This experimental study aimed at Development, Validation and Effectiveness of Computer Assisted Instruction (CAI) on the performance of IX class students in Mathematics. A Pre-test - Post-test single group experimental design was used on forty five students of IX class. In order to develop and find out the effectiveness of CAI Modules for secondary school students, the present venture has been taken up. The students may excel in their related fields if they are instructed with CAI Modules as it makes them learn the concepts with their pace and give them such a confidence that they can solve mathematical problems independently as CAI give main stress to individualized approach. The results revealed that Computer Assisted Instruction (CAI) was significantly higher in academic achievement of students in Mathematics. Findings supported that Computer Assisted Instruction (CAI) Modules enhance problem solving skills in students in Mathematics.

Keywords: *Effectiveness, Validation*, *Computer-Assisted Instruction (CAI), Academic Achievement*

1. Introduction

In the era of Science and Technology, the Computer becomes the integral part of our education system. It influences our education system at different levels and each stage like Elementary, Secondary and Higher education. It is playing an important role in enhancing the efficiency of the teaching-learning process, making students more attentive, confident and providing each student an individualized learning environment to learn at one's own pace. It is very useful to the teachers and the students as it lessens the burden of teaching and learning and it makes teaching and learning interesting. . It motivates the students and increases the enthusiasm of the students. The Association for Education Commissions and Technology (1977) has defined Computer-Assisted Instruction as a method of instruction in which the computer is used to instruct the students and where the computer contains the instruction which is designed to teach and test the student until a preferred level of proficiency is attained.

The subject like Mathematics find an important place at every level in our school curriculum. It provides opportunity for the intellectual gymnastic of one's inherent powers. The **Education Commission (1964-66)** recommended mathematics as a compulsory subject for all school students. Thus, mathematics enjoys a unique status in a school curriculum. **The National policy on Education (NPE- 1986)** also emphasizes that mathematics should be visualized as the vehicle to train a child to think, reason, analyze and articulate logically, apart from being a specific subject it should be treated as concomitant to any subject involving analysis and reasoning. For teaching Mathematics with the help of Computer-Assisted Instruction (CAI) as the name suggests, stands for the type of instruction aided or carried out with the help of a computer, help students to learn the abstract concept with clear understanding. The instruction provided with CAI would be very effective in teaching Mathematics with at every level of education system.

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2. Significance of the Study

Attainment or achievement in Mathematics is based on mastery of fundamental skills. The students' achievement in Mathematics is very low compared with other school students. It indicates that the Lecture method may not help the students to achieve more in Mathematics. Students do not have a positive attitude towards the study of Mathematics. Teaching Mathematics is a challenging area; in modern times, innovation in teaching brought a lot of changes in teaching and learning. However, the literature indicates mixed results regarding the effectiveness of this intervention on all students' mathematics achievement . Reseaches by Bahr, C.M. and Rieth, H.J. (1989), Chen T.Y. (1994), Hodge J. E. (2002), Thomas B. S. (2002), Hsu Yung-Chen (2003), Cannor T. R. (2005), Rosales J. S. (2005), Raninga, N. (2010), Pilli, O. and   Aksu, M. (2013), Safo, A.D., Ezenwa,V.I. and Wushishi, D.I.(2013) and Gambari, I.A., Ezenwa, V.I., and Anyanwu, R.C. (2014) etc. highlighted that the Computer-Assisted Instruction Modules are more effective as compared to lecture method of teaching. And it was found that there was a dearth of researches in the field of Mathematics for Secondary and Senior Secondary Class.

3. Objectives of the study

1. To develop and validate CAI modules for specified units in Mathematics for class IX school students.
2. To find the efficacy of CAI modules for specified units in Mathematics for class IX school students.

3. Hypothesis of the Study

1. CAI Modules would enhance problem solving skills in Mathematics for secondary school students.

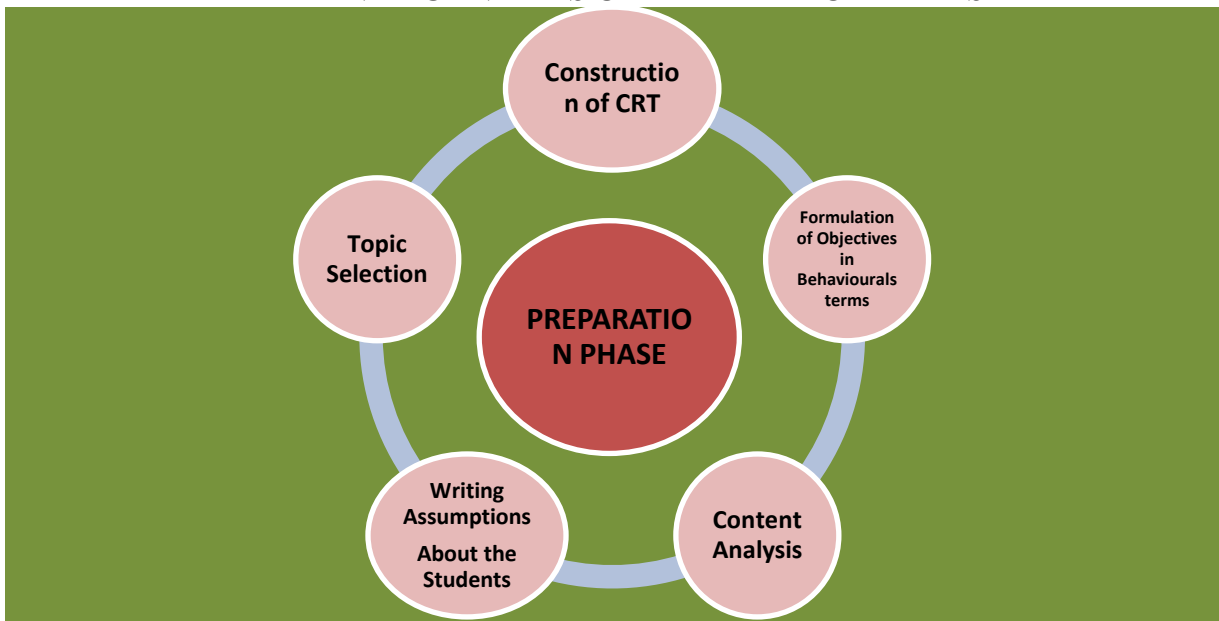## 4. Computer-Assisted Instruction (CAI) Modules

Computer-Assisted Instruction (CAI) is one of the methods of providing individualized and self-learning instructional material to the students. In this method, the study material is presented to the students after dividing it in small steps. The student advances only after learning each step. It has been used as an effective and efficient medium of instruction in the advanced countries for formal and non-formal education at all the levels. This method has contributed significantly in making the learning activity effective and simplified. The following four phases were used by the researchers to develop CAI Modules:

A. Preparatory Phase (Preparation of the CAI modules)
B. Development Phase (Writing of the CAI modules)
C. Try out phase (Testing of the CAI modules)
D. Evaluative Phase (Evaluation of the CAI modules)

A. PREPARATORY PHASE

Preparatory phase means all planning about the material which is to be done. During the preparation of an instructional material, a number of decisions were taken. These were about the topics to be selected for the instructional material, the students for whom it was developed, specific for the entry and terminal behavior, content analysis and the development of the criterion tests.

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FIGURE : 1
DIFFERENT ACTIVITIES OF PREPARATORY PHASE

I. Selection of the Topic

Three topics to be programmed were selected from First semester of class IX Mathematics text book. The topics selected were Lines and angles, Triangles and Quadrilaterals. The purpose of selecting these topics was that these were much of theoretical nature than practical ones. Also the software material on these topics could be developed in a simple, logical and systematic manner.

II. Writing Assumptions about the Students

The assumptions about the students for whom the CAI material was developed has consideration of selecting class IX students from English medium school, aged between 13 to 15 years of both gender boys and girls.

III. Content Analysis

Thirdly, the content analysis was prepared for three units in order to clear the aim that is what was to be taught under each topic. Infact, content analysis assists the teacher to determine the specific content which the student has to learn. In content analysis the knowledge to be taught was systematically organized.

IV. Writing objectives in Behavioural Terms

After the content analysis, the instructional objectives were formulated in the behavioral terms for three units for bringing change in the behaviour of the students.

V. Criterian referenced tests

Development of criterion referenced test is one of the important tests at preparatory phase of the development of programme. On the basis of formulation of instructional objectives, criterion referenced tests were constructed for three units for administration of students of IX class. The items written for the criterion referenced tests were of multiple choice questions. The items of the criterion tests, thus prepared, were carefully edited and reviewed for content relevance and learning outcomes as well as for technical accuracy and language. The help of subject matter experts and the language experts was taken at this stage.

Table :1 Criterion Referenced Test (CRT) Items in Each Unit

Sr.No.	Name Of The Unit	Test Items	Maximum Score
1	Lines & Angles	20	20
2	Triangles	20	20
3	Quadrilaterals	20	20
	Total	60	60

In each unit, scoring was based on the total items. Table:1 shows that each item scored one mark. The scores in the units were additive separately and the maximum score was 60.

A. DEVELOPMENT PHASE

Development phase means actual writing of the programme instructional material for CAI. While developing the software material, the principles of programmed learning were following up. The instructional material was broken into small segments and each segment was called a 'frame'. But before the students could go through the frames they were provided some specific instructions in each unit. After the first draft of the programme was developed, it was subjected to through review and editing process. Editing helped in knocking through edges off and pausing the material. This work was done in a hierarchical order at the following three levels:

a) Editing of the Subject Matter
b) Editing of the CAI Expert
c) Editing for the Composition

C. TRYOT PHASE

In this phase, instructional material was tested on students to evaluate its efficiency and effectiveness. This phase was divided into three sub-phases:

Figure : 2 Tryout Phase

Individual
(3 students)

Small Group
(8 students)

Field Group
(22 students)
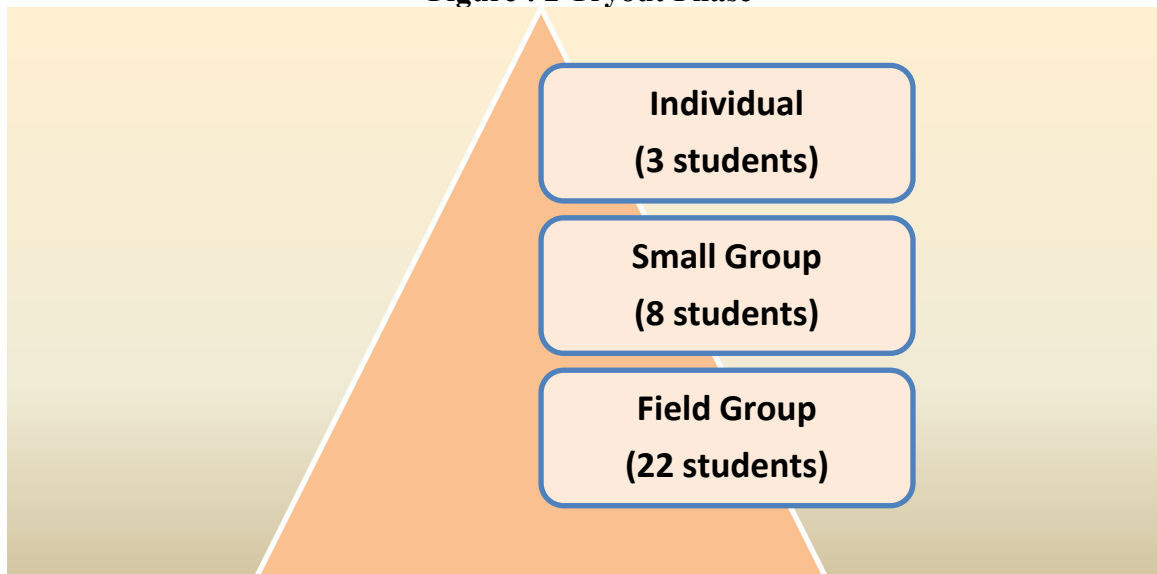
i. Individual tryout

In individual tryout, the CAI material was tried out on individual students of ninth class in a very informal situation. This tryout was done on three students separately. It was carried out with a view to know the student's reactions in respect to general instructions, instructional objectives, language used, examples given in the frames, the language and appropriateness of the questions and the material used in the software   material etc.

ii. Small group tryout

The modified instructional material (on the basis of the individual tryout) was then further tried out on a small group of the eight students. After giving instructions it was made sure that each one of them had understood the instructions about the way they had to go through the software material (CAI material). They were requested to be honest while responding to each frame. The reactions of this group were also noted. Improvements were made in the material on the basis of suggestions of the small group students.

iii. Field Tryout

For the final tryout the instructional material was administered on a group of 22 students of IX class Krishna Public School of Faridabad city. Both boys and girls were included iJn this group. No other help was provided, except for opening of instructional material.

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IV. Evaluation

Evaluation phase is the last stahe of developmental process of instructional material. For evaluation of the programme following steps was done to check the reliability and validity of the programme:

a. Error Rate: Error rate is generally calculated on the basis of students' responses obtained on each frame of the programme. If the student responded incorrectly to a frame, it was considered as an error. For each unit of programme the error made by the individual students on all the responses were noted. And to arrive at the percentage of error, the total number of errors made by all the students was multiplied by 100 and the product so obtained was divided by the product of the total number of students handling the programme and the total number of required responses in the frames as per formula given below:

$$\text{Error Rate (\%)} = \frac{Ne \ X \ 100}{Nr \ X \ Ni}$$

where, Ne = Total number of errors made by all the students on the programme.

Ni = Total number of students handling the programme.

Nr = Total number of required responses in the programme.

According to this specified formula the error rate was calculated for three units which is given in the table 2

Table : 2
Error Rate on the Basis of CRT of Three Units

Sr. No.	Name of the Unit	Ne	Nr	Ni	Error - Rate
1	Lines & Angles	58	20	22	13.18%
2	Triangles	52	20	22	11.81%
3	Quadrilaterals	50	20	22	11.36%

As is clear from the table 2, the error rate of all the three units range from 11.36% -13.18% was less than fifteen. This, in other words, indicated that all the modules were comprehensible to the students of the target population.

EFFICACY OF CAI MODULES: The Second objective of this research was to investigate the efficacy of CAI Modules for specified units in Mathematics for class IX school students. **PRE-TEST-POST-TEST SINGLE GROUP DESIGN** was used to meet this objective. In order to see the difference between pre-test and post-test scores, t-test was computed.

TABLE : 3
Significant Difference Between Pre-Test and Post-Test of
Unit I (Lines & Angles), Unit-II (Triangles) & Unit-III (Quadrilaterals)

Unit	Group	N	Mean	S.Ed	t-Value	Level of Significance
Lines & angles	Pre-Test	22	3.27	2.19	16.65	AT 0.01 LEVEL
	Post-Test	22	14.31			
Triangles	Pre-Test	22	3.68	2.78	12.14	AT 0.01 LEVEL
	Post-Test	22	14.00			
Quadrilaterals	Pre-Test	22	4.09	2.13	16.10	AT 0.01 LEVEL
	Post-Test	22	14.45			

It can be observed from the table 3 that the mean score of Pre-test and Post-test of unit-I (LINES & ANGLES) are found to be 3.27 and 14.31 with SEd 2.19. The mean score of Pre-test and Post-test of unit-II (TRIANGLES) are found to be 3.68 and 14.00 with SEd 2.78. The mean score of Pre-test and Post-test of unit-III (QUADRILATERALS) are found to be 4.09 and 14.45 with SEd 2.78 and the t-value between the Pre-test and Post-test Single Group of unit-I , unit-II and unit-III come out to be 16.65, 12.14 and 16.10 respectively and the value of t-test for each three units are significant at 0.01 level. Hence, it can be interpreted that efficacy of CAI Modules of three units were established.

FIGURE : 3
DIAGRAMATIC REPRESENTATION OF THE SIGNIFICANT DIFFERENCE BETWEEN THE MEAN OF ACHIEVEMENT SCORES OF CAI MODULES ON PRE-TEST AND POST-TEST OF UNIT I (LINES & ANGLES), UNIT-II (TRIANGLES)& UNIT-III (QUADRILATERALS)
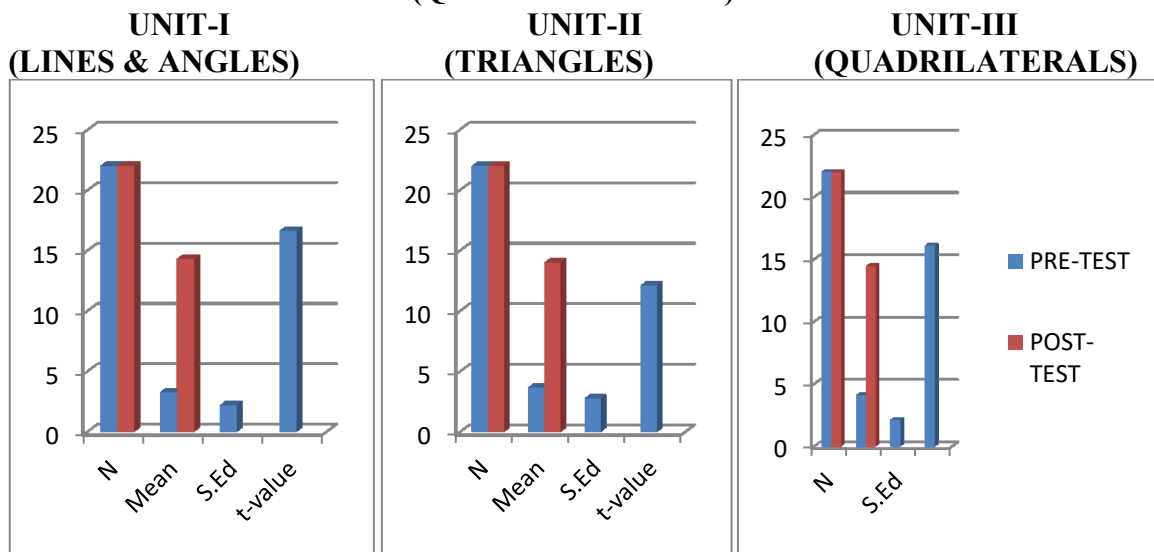

Figure 4 shows the mean achievement scores of Pre-test and Post-test of unit-I (LINES & ANGLES), UNIT-II (TRIANGLES)& UNIT-III (QUADRILATERALS). Figure also reveals that when students were exposed to CAI modules then they learnt the concept with full attention. The reason for that students learnt the concept at their own pace and scope of providing to do lots of practice for concept clarity in CAI Modules.

Educational Implications
This study aimed at developing problem solving skills among secondary school students. For this, CAI modules was developed. The material was evaluated by establishing reliability and validity. So, training should be provided to pre-service as well as in-service teachers for developing CAI modules. It is also required to orient the Mathematics teachers for developing positive attitude for the use of CAI modules for enhancing problem solving in Mathematics.

One of the findings of this experimental study highlights the efficacy of CAI modules. This finding has direct implication for teachers, teacher educators and administrators. The teacher educators should encourage the teachers to use CAI modules in Mathematics. These modules can also beneficial for students to learn according to their pace and solve the Mathematical problems independently. This method helps the teachers to motivate the students for solving Mathematical problems in an effective manner. Through these modules, teachers create environment for developing problem solving skill among students.

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