

Computer Assisted Instruction and Teaching of Arithmetic

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Abstract- This True Experimental study compared academic performance of students in class VIII in initial tryout in one of the English Medium Schools of Vadodara, India among three methods of teaching arithmetic subject viz. (i) Conventional Method (in control group –C), (ii) Computer Assisted Instruction (CAI) only (in Experimental Group A - Exp A) and (iii) Computer Assisted Instruction with simultaneous discussion (in Experimental Group B - Exp B). After experimentation in the initial tryout, CAI was modified according to the comments given by the students of the groups (Exp A and Exp B), mathematics teacher and the observations made by the investigators. The modified version of CAI used in the final tryout in another school. Methodology used in both the tryouts is as follows. The design used in this study was post-test only control group design. Three sections of class VIII students selected and groups randomly allotted. ANOVA and Tukey HSD Test used for data analyses. In both the tryouts there was significant difference in the posttest scores of students receiving conventional method, CAI only and CAI with simultaneous discussion. Further data were analysed using Tukey HSD test. In both the tryouts level of significance was at .05. In Initial Tryout findings revealed that (1) there was significant difference between mean achievement score of Exp B and Exp A (2) there was significant difference between mean achievement score of Exp B and Control Group (3) there was no significant difference between Exp A and Control Group. In final tryout findings revealed that (1) there was no significant difference between mean achievement score of Exp A and Control Group (2) there was no significant difference between mean achievement score of Exp A and Exp B. (3) There was significant difference between mean achievement score of Control Group and Exp B.

Index Terms: Computer Assisted Instruction, Self Learning Material, Auto Instructional Method, Simultaneous Discussion and Symbolic language.

1. INTRODUCTION

Education gives skill and competency to the individual for a successful living. It is an instrument of social change, modernization, development, economic and social development of a country. The 21st century world can be called a scientific world, advancing rapidly in information technology, medicine, engineering, space communication, astronomy, astrophysics, artificial intelligence, robotics and many other disciplines. Our country requires technically skilled manpower. For all disciplines mathematics is the base. India has a rich Mathematical heritage. An Instrument was actually used for drawing circles in the Indus

valley as early as 2500 BC. Several significant contributions to the world of mathematics have been made during the last two millennia, for example, by Aryabhata I(475 AD), Brahma Gupta(7th Century), Mahavira(850AD), Bhaskara II(1150 AD), Madhava(14th Century), Ramanujan(1887-1920). (NCERT, 1971) 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. Yet many school students find difficulty with learning of mathematics and fail in mathematics. A major reason for the failure is that the teachers quite often pay no attention to the basic concepts and generally adopt methods of solving questions with crammed up formulae. In order to overcome the difficulties faced by the students, teacher should adopt different methodology in teaching of mathematics like drill method, using different audio visual aids, computer aided instruction, mathematical club etc. One of the methods is auto-instructional method. It is a method of individualized instruction. One of its forms is CAI (Computer Assisted/Aided Instruction) auto instructional teaching. 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 also helps the students to learn at their own pace and at their own convenience. It motivates the students and increases the enthusiasm of the students. In this method students read different frames and answer the questions that follow and by this way they learn automatically. Even the learning that takes place through CAI is accurate and untiring. The most beneficial part of CAI is it provides the mixture of wide range of visual, graphics and pictures to make the teaching learning more interesting. Investigators have developed the Computer Assisted Instruction for teaching and learning mathematics for class VIII students in arithmetic portion and tested the effectiveness of the developed CAI.

2. COMPUTER ASSISTED INSTRUCTION IN LEARNING MATHEMATICS

ICT (Information and Communication Technology) has great potential for teaching and learning process at all levels. The use of ICT has enriched the teaching learning process with the help of computer. It has brought a great change, innovativeness, and creativity in teachers in teaching learning process. Mathematics and computer are both important in today's life as they open the

gate of ample opportunities in this modern world. Mathematics is widely used in computers both in hardware and software. Computer helps in improving the knowledge of mathematics. It helps in making classroom teaching lively. It plays vital role in learning process as it works with the imagination of students. Any concept in mathematics can be explained with the help of pictures and this visual image can help in understanding the concept at ease. In paper pencil method student can get bored easily and can find it difficult to practice the sum again and again. CAI works as a change and increases the curiosity of students and they can learn interestingly without any difficulty. Also whatever is learnt through computer aided instructions, the contents can be retained for longer time as they use more senses of the students. (project, 2000) CAI brings with it several potential benefits as a teaching/learning medium. These include self-paced learning, self-directed learning, the exercising of various senses and the ability to represent content in a variety of media. Humans are multi-sensory animals. Certain chapters like Profit and loss, Simple and compound interest can be explained very easily using CAI. Variety of exercises can be provided and this ensures active involvement of the students. The material can be provided according to the needs of the students.

3. RATIONALE OF THE STUDY

Many studies have been conducted on low achievements in mathematics. (Jain & Burad, 1988) studied the low results in mathematics at Secondary Examination in Rajasthan and found that the cause of failure was non-availability of mathematics teachers due to late appointments and frequent teacher transfers; lack of appropriate classrooms. (Chel, 1990) found that the causes responsible for under achievements were gaps in knowledge of concepts, difficulties in understanding of mathematics language. These studies clearly show that students find difficulty in learning mathematics and there is a need to develop some self learning material to make learning easy. Many studies have been conducted to find out the effectiveness of CAI in terms of achievement of the students in learning. (Jeyamani, 1991) found that experimental group performed better on post test. The studies conducted by (Rose Antony Stella, 1992), (Adhikari, 1992), (Barot, 2005), (Khirwadkar, 1998), (Singh, 1992) and (Zyoud, 1999) showed that CAI was effective than conventional method. (Vansia, 2011) in his study found that mathematics learning through CAI with Peer Instruction (CAIPI) was effective on post-test. (Spradlin, Dye, & Ackerman, 2010) found that there was no statistically significant difference in the post-test scores of students receiving traditional instruction and traditional instruction supplemented with computer assisted instruction. Results of the present study may initiate changes in

teaching and learning mathematics, in the instructional modes in order to enhance mathematical achievement for all students. With information about the potential impact of computer assisted instruction, institutions can invest their resources wisely. In addition, it may lead to investigation on students' highest achievement in the various delivery formats.

4. METHODOLOGY OF THE STUDY

4.1 The Present Study Entitles

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4.2 Objectives of The Study

- To develop the CAI in Mathematics for Standard VIII students studying in schools affiliated to GSHSEB (Gujarat State Secondary and Higher Secondary Education Board).
- To study the effectiveness of the developed CAI in terms of students' achievement in Mathematics with one of the Experimental Groups (Exp A) of standard VIII students.
- To study the effectiveness of the developed CAI in terms of students' achievement in Mathematics with another experimental group (Exp B) of standard VIII students along with treatment of simultaneous discussion.
- To study the relative effectiveness of learning mathematics in class VIII among the three experimental groups A, B and C (Where C is the control group and A and B are experimental groups) in terms of achievement of the students.

4.3 Hypotheses of The Study

- There is no significant difference between Experimental group A (Exp A) and Control Group (C) towards effectiveness of the developed CAI.
- There is no significant difference between Experimental group B (Exp B) and Control Group (C) towards effectiveness of the developed CAI.
- There is no significant difference between Experimental group A (Exp A) and Experimental group B (Exp B) towards effectiveness of the developed CAI.

4.4 Explanation of The Terms

CAI with Discussion: In the context of the present study CAI with discussion means the learners learned arithmetic unit with the help of CAI along with the simultaneous discussion led by the investigators with students where ever and whenever needed.

4.5 Operationalization of Terms

- CAI: For the purpose of this study CAI means Computer Assisted Instruction, which is a self-learning material developed by the investigators after observation of mathematics classroom to understand the student's ability, potential, grasping power and other learning behaviour.
- Achievement in Mathematics: The mark scored by each student in the test constructed by the investigators on the arithmetic unit was the achievement of that student.
- Effectiveness: In the context of the present study, effectiveness refers to relative increase in the scholastic achievement of the experimental groups (Exp A and Exp B) student compared to that of control group students.

4.6 Delimitation of The Study

The present study was delimited to standard VIII English Medium GSHSEB students and only arithmetic unit of the mathematics textbook in the year 2010 was covered during experimentation of the present study.

4.7 Design of The Study

The present study was true experimental in nature. True experimental design was followed in this present study. The design was post-test-only control group design.

4.8 Population of The Study

There are 61 grant-in-aid schools in the city of Vadodara, functioning under the Gujarat State Board of secondary and Higher Secondary Education (GSHSEB) following the rules and regulations laid by the Ministry of Human Resources of the Government of India. The population of the study consists of all the Standard VIII English medium students of GSHSEB of Vadodara city in the year 2010.

4.9 Sample and Procedure of The Study

Initial Try out

For initial try out Standard VIII students of three sections of one of the English Medium schools of Vadodara were taken for the present study. These selected sections (A, B, C) were assigned randomly as Exp A, Exp B and control group (C). For ANOVA calculation, groups were matched on the basis of comparable mean and standard deviation based on their VII standard mathematics marks. All students in three sections participated in the study but only matched group students were considered for the calculation purpose. Students of section C (13 students) were selected as control group who were taught by conventional method. Students of Section B (13 students) were selected as Experimental Group A who were taught by using CAI only. Students of section A were selected as Experimental Group B (13 students) who were taught by using CAI with simultaneous discussion. Each group was taught for one period daily over a period of one month. After completion of teaching the arithmetic content viz. profit and loss, simple interest and compound interest topics, students were tested through scholastic achievement test prepared by the investigators and validated by the experts on the basis of content analysis.

CAI was further modified according to the suggestions given by the students, mathematics teacher and observation by the investigators. Modified CAI was used for final tryout.

Final Try out

For final try out Standard VIII students of three sections of one of the English medium schools of Vadodara were taken for the present study. These selected sections (A, B, C) were assigned randomly as Exp A, Exp B and control group (C). For ANOVA calculation, groups were matched on the basis of comparable mean and standard deviation based on their mathematics achievement test prepared by the investigators. All students in the three sections participated in the study but matched group students were considered for the calculation purpose. Students of section B (20 students) were selected as control group (C) who were taught by conventional method. Students of section A (20 students) were selected as Experimental Group A who were taught by CAI only. Students

of section C (20 students) were selected as Experimental Group B who were taught by CAI with simultaneous discussion. Each group was taught for one period daily over a period of one month. After completion of teaching the arithmetic content viz. profit and loss, simple interest and compound interest topics, students were tested through scholastic achievement test prepared by the investigators and validated by the experts on the basis of content analysis.

4.10 Tools for Data Collection

The investigators prepared Scholastic Achievement test based on content analysis serving the purpose of posttest. The experts validated the test.

4.11 Plan and Procedure Of Data Collection

Step 1: One of the English medium school of Vadodara, India following GSHSEB syllabus class VIII students were selected purposively having the required facility to conduct the experiment.

Step 2: Students were divided randomly into three groups control group taught by usual conventional method, Experimental Group A (only CAI) and Experimental Group B (CAI with simultaneous discussion).

Step 3: Students were taught in their respective methods for a month for the completion of the selected arithmetic unit.

Step 4: Test was administered to the students and their marks were collected and analysed.

Step 5: CAI was modified according to the suggestion of the students, mathematics teacher and the observation made by the investigators. The modified CAI was used for final tryout.

Step 6: Steps 1 to 4 is followed as above.

5. LIMITATIONS OF THE PRESENT STUDY

The present study was limited to arithmetic unit of Class VIII GSHSEB text book and therefore whole content of mathematics textbook was not covered. The duration of the study was one month for each tryout. Data was analysed using quantitative methods only.

6. DATA ANALYSIS

Collected data were analyzed through appropriate statistical techniques. To study the effectiveness of the developed CAI, ANOVA was computed.

6.1 Initial Tryout

Table 1: Data for One-Way ANOVA for 3 Samples –Post test scores (Marks out of 100)

S.No.	Control Group	Experimental Group A	Experimental Group B
1	40.00	26.67	93.33
2	46.67	33.33	80.00
3	53.33	33.33	66.67

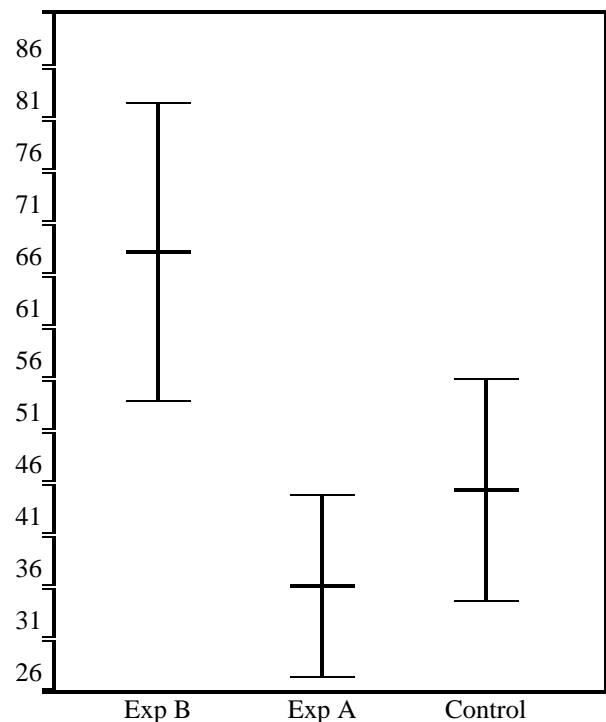
S.No.	Control Group	Experimental Group A	Experimental Group B
4	53.33	40.00	73.33
5	60.00	40.00	93.33
6	40.00	40.00	73.33
7	60.00	20.00	60.00
8	33.33	46.67	73.33
9	60.00	20.00	60.00
10	33.33	40.00	46.67
11	40.00	40.00	46.67
12	53.33	46.67	60.00
13	26.67	46.67	80.00

Table 2: Data Summary

Samples	Control	Exp A	Exp B	Total
N	13	13	13	39
$\sum X$	599.99	473.34	906.66	1979.99
Mean	46.1531	36.4108	69.7431	50.769
$\sum X^2$	29243.42	18267.333	65953.911	113464.666
Variance	129.3365	86.055	226.7211	340.5949
Std.Dev.	11.3726	9.2766	15.0573	18.4552
Std.Err.	3.1542	2.5729	4.1761	2.9552

Table 3: ANOVA Summary

Source	SS	df	MS	F	P
Treatment [between groups]	7637.2547	2	3818.6274	69.74	<.0001
Error	3947.1602	24	164.465		
Subjects	1358.1904	12			
Total	12942.6054	38			



Graph 1: Graphical Representation of Result of Initial Tryout

Control Group:

Mean = 46.15
Standard Deviation = 11.4
High = 60.00 and Low = 26.67, Median = 46.67
Average Absolute Deviation from Median = 9.74

Experimental Group A:

Mean = 36.41
Standard Deviation = 9.28
High = 46.67 and Low = 20.00, Median = 40.00
Average Absolute Deviation from Median = 6.67

Experimental Group B:

Mean = 69.74
Standard Deviation = 15.1
High = 93.33 and Low = 46.67, Median = 73.33
Average Absolute Deviation from Median = 11.8.

Table 4: Result of Tukey HSD Test

HSD[.05]=12.57;	M1 = mean of Exp B
HSD[.01]=16.19	M2 = mean of Exp A
M1 vs M2 P<.01	M3 = mean of Control Group
M1 vs M3 P<.01	
M2 vs M3 non significant	

HSD = the absolute [unsigned] difference between any two sample means required for significance at the designated level. HSD[.05] for the .05 level; HSD[.01] for the .01 level.

6.2 Final Tryout

Table 5: Data for One-Way ANOVA for 3 Samples- Post Test Scores (Marks out of 100)

S.No.	Control Group	Experimental Group A	Experimental Group B
1	35	40	40
2	86.67	45	53.33
3	66.67	73.33	86.67
4	93.33	80	80
5	66.67	93.33	93.33
6	35	86.67	100
7	45	86.67	100
8	40	86.67	100
9	80	93.33	100
10	33.33	86.67	100
11	86.67	80	100
12	93.33	86.67	86.67
13	45	86.67	100
14	80	50	40
15	86.67	80	73.33
16	93.33	73.33	100
17	40	50	80
18	80	66.67	86.67
19	93.33	66.67	93.33
20	86.67	86.67	100

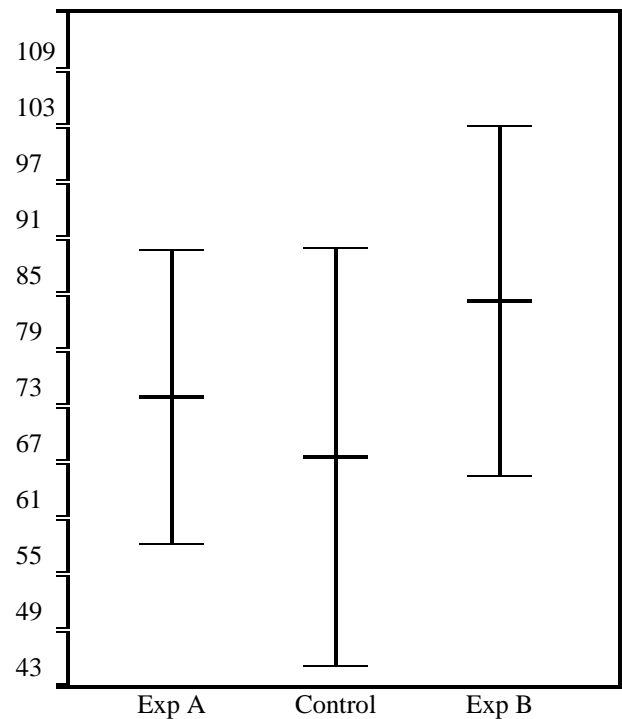
Table 2: Data Summary

Sample s	Control	Exp A	Exp B	Total
N	20	20	20	60
$\sum X$	1366.67	1498.35	1713.33	4578.35
Mean	68.3335	74.9175	85.6665	76.3058
$\sum X^2$	103789.37	117472.15	154177.42	375438.95
Varian	547.3702	274.7116	389.602	442.1041

Sample s	Control	Exp A	Exp B	Total
ce				
Std.Dev.	23.3959	16.5744	19.7383	21.0263
Std.Err.	5.2315	3.7062	4.4136	2.7145

Table 3: ANOVA Summary

Source	SS	df	MS	F	P
Treatment [between groups]	3062.153	2	1531.0765	4.73	0.014644
Error	12303.0214	38	323.7637		
Subjects	10718.9695	19			
Total	26084.1439	59			



Graph 1: Graphical Representation of Result of Final Tryout

Control Group:

Mean = 68.33
Standard Deviation = 23.4
High = 93.33 and Low = 33.33, Median = 80.00
Average Absolute Deviation from Median = 19.7

Experimental Group A:

Mean = 74.92
Standard Deviation = 16.6
High = 93.33 and Low = 40.00, Median = 80.00

Average Absolute Deviation from Median = 12.4

Experimental Group B:

Mean =85.67

Standard Deviation = 19.7

High = 100 and Low =40.00, Median = 93.33

Average Absolute Deviation from Median = 13.7

Table 4: Result of Tukey HSD Test

HSD[.05]=13.88; HSD[.01]=17.65 M1 vs M2 non significant M1 vs M3 non significant M2 vs M3 P<.05	M1 = mean of Exp A M2 = mean of Control Group M3= Mean of Exp B HSD = the absolute [unsigned] difference between any two sample means required for significance at the designated level. HSD[.05] for the .05 level; HSD[.01] for the .01 level.
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7. FINDINGS OF THE STUDY

Following are the major findings obtained from the data analysis of Post test.

7.1 Initial Tryout

Initial try out using inferential statistics ANOVA at .05 level of significance it was found that there was significant difference between the mean achievement score of Experimental Group A, Experimental Group B and the Control Group (C) . Further using Tukey HSD Test it was found that

- i . There was no significant difference between the mean achievement score of Experimental Group A (only CAI) and the Control Group (C) (Conventional Method).
- ii. There was significant difference between the mean achievement score of Experimental Group B (CAI with simultaneous discussion) and the Control Group (C) (Conventional Method)
- iii. There was significant difference between the mean achievement score of Experimental Group A (only CAI) and the Experimental Group B (CAI with simultaneous discussion)

7.2 Final Tryout

Final try out using inferential statistics ANOVA at .05 level of significance it was found that there was significant difference

between the mean achievement score of Experimental Group A, Experimental Group B and the Control Group. Further using Tukey HSD Test it was found that

- i. There was no significant difference between the mean achievement score of Experimental Group A (only CAI) and the Control Group (C) (Conventional Method).
- ii. There was significant difference between the mean achievement score of Experimental Group B (CAI with simultaneous discussion) and the Control Group (C) (Conventional Method)
- iii. There was no significant difference between the mean achievement score of Experimental Group A (only CAI) and the Experimental Group B (CAI with simultaneous discussion)

8. DISCUSSION

The findings of the present study reveal several interesting observations concerning class VIII arithmetic and computer-assisted instruction which are discussed further. The result of this study in both initial and final tryout indicated that students learn better using CAI with simultaneous discussion than the usual conventional method. Therefore, it can be concluded that CAI with simultaneous discussion helped students in understanding the concept better and helped in increasing their score in the arithmetic test. The results of initial and final tryouts indicated that students learned equally well through both the methods viz. conventional method and CAI only. Therefore, CAI can be replaced with conventional method whenever there is necessity like non availability of mathematics teachers or may be any other reason. So, if CAI is developed in the arithmetic topics wherever possible it will help students and school authorities to continue teaching during crisis such as in absence of teacher/ students. The result of initial tryout indicated that students learn better using CAI with simultaneous discussion than CAI only. Whereas, result of final tryout indicated that students learn equally well using CAI only and CAI with simultaneous discussion. In initial tryout investigators observed that students were of average level, school had less computer facility, most of the time few computers were not working and therefore few students have to share their computers, whereas in final tryout students were of above average level, school had good computer facility, all computers were in working condition and students

had separate computers throughout the session. Moreover, in initial tryout students needed investigators help most of the time because of the problems they faced using the computers. Whereas, in the final tryout students didn't face any such problems using the computer and they were able to operate by themselves. Experimental Group B students asked doubt whenever they faced problems in understanding the concept. So, it can be concluded that students learn better in CAI with simultaneous discussion than with CAI only (in similar condition of schools like initial tryout). Students learn equally well using CAI with or without the presence of teacher (in similar condition of schools like final tryout). Hence it follows that computers have the potential to be useful tools to improve learning. Educators can tap into this interest by using CAI to deliver instruction and assess learning in arithmetic. Technological advances have made computers more powerful and less expensive, which has resulted in more students having access to computers. Computer learning systems provide educators the opportunity to present topics in a variety of alternative forms as compared to the conventional method in order to address the different learning styles and preferences of students. Educators using the conventional method of teaching may consider supplementing their method of teaching with the help of CAI so as to enhance students learning and motivation.

9. EDUCATIONAL IMPLICATION OF THE PRESENT STUDY

Students enjoyed learning arithmetic through CAI and it helped students as a supplementary material. Self learning material should be developed in mathematics where ever possible for all classes and should be used along with the conventional method to make learning an enjoyable and pleasant experience.

10. CONCLUSIONS

(Brown, 2003) (Kinney & Robertson, 2003) concluded that CAI offers students an opportunity to be actively engaged in the learning process, to receive instruction through a variety of multimedia, to choose the place and time to learn, to work at their own pace, and to receive immediate and accurate feedback. (Ramani & Patadia, 2012) in their study titled Comparative Analysis of Reaction of Students on Final Version of Computer Assisted Instruction for Teaching Arithmetic with Different

Modes, (Ramani & Patadia, 2012) in their study titled the effectiveness of Computer Assisted Instruction in Teaching Arithmetics and (Ramani & Patadia, 2013) in their study titled Reaction of Students on Developed Computer Assisted Instruction For Teaching Arithmetic have studied the effectiveness of using CAI in teaching and learning mathematics and found that CAI is one of the effective methods to teach and learn mathematics. In the present study from the findings and from observations of the investigators it was found that students enjoyed learning mathematics through CAI. So it can be concluded that CAI is one of the effective ways to teach and learn mathematics with arousing interest among students.

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