

**CAI AND CONVENTIONAL METHOD IN CALCULUS: AN EMPIRICAL STUDY**

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**ABSTRACT**

This experimental study aimed at comparing the effect of Computer Assisted Instruction (CAI) and Conventional Method on the performance of undergraduate students in Calculus. The significance of attainment and retention scores for experimental group (using CAI) and control group (using conventional method) were examined in this study. The sample of ninety female undergraduates was selected from Banasthali Vidyapith, Rajasthan, India. Researchers developed and validated Computer Assisted Instructional Material (CAIM), Calculus Achievement Test (CAT), Parallel Calculus Achievement Test (PCAT) and lesson plans for Limit and Continuity in Calculus. The Pre-test - Post-test Equivalent - Groups Design was used. Results revealed the significant difference between experimental group and control group in attaining and retaining Calculus. Findings supported CAI for better performance in mathematics.

**KEYWORDS:** CAI, CAIM, Conventional Method, Calculus.

**INTRODUCTION**

Technology has great importance in day-today life. The field of education is not away from its impact. Creation of a thrilling learning environment in boring classroom is also an impact of modern technological methods. These methods can enrich traditional course and improve the quality of instruction. In this era of technology, Computer Assisted Instructions (CAI) is an interactive technological method of instruction which can be used for teaching abstract concepts. It is a usable way to make instruction more stimulating. One of the benefits of CAI is the instant feedback for learners. In this study, CAI is used to deliver individualized instruction and compared with Conventional Method in Calculus at under graduate level.

**RESEARCH PROBLEM**

Calculus is an essential part of mathematics. It is the mathematical study of change. Limit and Continuity are very important topics of Calculus which have many applications in

different disciplines at undergraduate level. In Limit and Continuity, the concepts of  $\epsilon$ - $\delta$  definition (formal definition) and kinds of discontinuities are found difficult to understand. These concepts are usually delivered by Conventional Method (chalk and talk approach) in Indian Situations. Besides this, many students do not ask questions regarding clarity of concepts in traditional classroom. Thus the need of hour is to use interesting strategies and effective instructional material for interactive classroom. Researchers in [2], [9] & [12] recommended the need of technology in Calculus Education. Also, Lot of researches [1], [3], [4], [5], [6] & [10] on CAI revealed that new technologies and software for CAI should be implemented in mathematics classroom at different level of teaching. But there is lack of researches on CAI in Calculus at undergraduate level in Indian situations. Therefore, researchers decided to develop and validate the tools on Limit & Continuity in Calculus. They also compared the effectiveness of CAI and Conventional Teaching in Calculus at undergraduate level.

### **RESEARCH OBJECTIVES**

The objectives of this study were to

- Develop and validate the instructional and measuring tools for CAI and Conventional Method in Calculus at undergraduate level.
- Study the effectiveness of instructional material for CAI and Conventional Method in attaining Calculus at undergraduate level.
- Assess the effectiveness of instructional material for CAI and Conventional Method in retaining Calculus at undergraduate level.
- Compare the performance of undergraduates in Calculus for experimental and control group using CAI and Conventional Method respectively.

### **HYPOTHESIS**

Hypotheses in this study were framed as follows:-

- There exists no significant difference in mean attainment score of Calculus in experimental group and control group from Pre- test to Post – test I.
- There exists no significant difference in mean retention score of Calculus in experimental group and control group from Pre- test to Post – test II.
- There exists no significant difference in mean attainment score of Calculus in experimental group and control group at Pre-test stage (Entry Level).
- There exists no significant difference in mean attainment score of Calculus in experimental group and control group at Post-test stage I (Attainment Level).

- There exists no significant difference in mean retention score of Calculus in experimental group and control group at Post-test stage II (Retention Level).

### **RESEARCH METHODOLOGY**

In this true experimental study, Pre-test – Post-test Equivalent – Groups research design was used.

### **PARTICIPANTS**

The sample for this experimental study was selected according to the availability of computers in mathematics classroom of Banasthali Vidyapith, Rajasthan, India. It included 90 female undergraduates, who offered mathematics as elective subject.

### **DEVELOPMENT AND VALIDATION OF TOOL FOR DATA COLLECTION**

The researchers developed the instructional and measuring tools on Limit and Continuity in Calculus. It included two sessions on Formal definition of the limit of a function, Continuous functions and classification of discontinuities. They developed CAIM (Computer Assisted Instructional Material) for CAI (in Microsoft office word 2007 using hyperlinks) and Lesson plans for Conventional teaching. Developed CAIM looked like a test but it was not a test. It was a self-learning material where mode of instruction was computer. Two Criterion Referenced tests, CAT (Calculus Achievement Test) and PCAT (Parallel Calculus Achievement Test) for two sessions of Limit and Continuity, along with their scoring keys were also developed by the researchers. The content validity of these tools was determined by subject experts and expert in Educational Technology. Editing of content material was done in individual and small group try-outs. The instructional tool CAIM was validated in terms of learning gain scores (.92), reliability co-efficient of CAT and PCAT was also calculated as Kappa co-efficient (.84). It was calculated in terms of mastered and non-mastered group using the criteria of 85 % success in pilot study for 33 undergraduates ([7] & [11]). In this study, Raven's Standard Progressive Matrices (SPM) having five sets A, B, C, D and E with re-test reliability 0.83 to 0.93 was used to measure the intelligence of the Undergraduates. Personal information of undergraduates regarding name, age, area (rural /urban), roll no, class was also gathered.

### **PROCEDURE OF FINAL EXPERIMENT**

Ninety female undergraduates from two sections of B.A. / B.Sc. third semester participated in this study after matching their level of intelligence and Pre-test score. Each group had 45 students. The experimental group was exposed to CAI and Conventional Method was used for control group. After the treatments, both the groups were post- tested. After seven days, both groups were retested. CAT was used for Pre-test and Post - test I and PCAT (Alternate form of CAT) was used for Post-test II. The scores of Pre-test, Post-test I and Post-test II

were recorded for comparative study of CAI and Conventional Method in Calculus at undergraduate level. Method and Procedure of the final experiment is shown below (Fig.1):-

**Fig. 1: Method & Procedure of final experiment**

Groups	Pre-Test ( Entry Level )	Treatment	Post-test I (Attainment Level)	Post- test II (Retention Level)
Random	Intelligence Test, CAT( Calculus Achievement Test)	Experimental Group using CAI	CAT ( Calculus Achievement Test)	PCAT (Parallel Calculus Achievement Test)
Random	Intelligence Test, CAT( Calculus Achievement Test)	Control Group using Conventional Method	CAT ( Calculus Achievement Test)	PCAT (Parallel Calculus Achievement Test)

**RESULTS AND DISCUSSIONS**

In order to analyze the data, SPSS v.16 was used. Matched t-test was used to compare Pre-test and Post-test results in each group. Independent t-test was used to compare Pre-test and Post-test results of CAI and Conventional Teaching. This study revealed the following results (Table 1 to Table 5):-

**Table 1:Results of Paired Samples Test for Experimental Group**

Attainment	Paired Difference		t	df	Sig. (2-tailed)
	Mean	Std. Deviation			
Pair 1 POSTI – PRE	33.600	3.374	66.810	44	.000

**Table 2: Results of Paired Samples Test for Control Group**

Attainment	Paired Differences		t	df	Sig. (2-tailed)
	Mean	Std. Deviation			
Pair 1 POST1 - PRE	31.622	3.453	61.436	44	.000

- There exists significant difference ( $p = .00 < .05$ ) in mean attainment score of Calculus in experimental group and control group from Pre- test to Post – test I (Table 1 & Table 2). It clearly indicates the gain from pre-test to post-test performance for CAIM in experimental group and lesson plans in control group in attaining Calculus.

**Table 3: Results of Paired Samples Test for Experimental Group**

Retention	Paired Differences		t	df	Sig. (2-tailed)
	Mean	Std. Deviation			
Pair 1 POSTII - PRE	31.566	3.441	61.510	44	.000

**Table 4: Results of Paired Samples Test for Control Group**

Retention	Paired Differences		t	df	Sig. (2-tailed)
	Mean	Std. Deviation			
Pair 1 POSTII- PRE	29.067	4.191	46.526	44	.000

There exists significant difference ( $p = .00 < .05$ ) in mean retention score of Calculus in experimental group and control group from Pre-test to Post – test II (Table 3 & Table 4). It also indicates the effectiveness of instructional material in retaining Calculus.

**Table 5: The results of Independent Sample t-test for Experimental Group & Control Group**

Stages	Mode	Mean	Std. Deviation.	df	p-value
Pre	CAI	12.78	4.084	88	.904
	CONV	12.89	4.653		
Post I	CAI	46.38	2.741	88	.001
	CONV	44.51	2.455		
Post II	CAI	44.33	2.705	88	.000
	CONV	41.96	2.468		

- There exists no significant ( $p = .904 > .05$ ) difference in mean attainment score of Calculus in experimental group and control group at Pre-test stage. Thus null hypothesis is accepted. Hence both groups have similar entry level (Table 5).
- There exists significant difference ( $p = .001 < .05$ ) in mean attainment score of Calculus in experimental group and control group at Post-test stage I (Table 5). Therefore null hypothesis is rejected. This indicates the better performance of experimental group in attaining Calculus at undergraduate level.
- There exists significant difference ( $p = .000 < .05$ ) in mean retention score of Calculus in experimental group and control group at Post-test stage II (Table 5). So, alternate hypothesis is accepted. It also points out the better performance of experimental in retaining Calculus at undergraduate level.

## **CONCLUSION**

The findings of this empirical study revealed the effectiveness of instructional material for CAI and Conventional Method in attaining and retaining Calculus at undergraduate level. But performance of experimental group supported CAI as better mode of instruction in Calculus at undergraduate level. This study may help the mathematicians to choose CAI as teaching device at undergraduate level. The use of CAI can improve performance of undergraduates in mathematics at their own speed in Indian situations. User friendly Software packages for different levels of learners for different subjects can be developed and used for effective teaching-learning process.

## **ACKNOWLEDGEMENT**

The first author wishes to acknowledge UGC New Delhi for awarding teacher fellowship, the authorities of Kurukshetra University, Kurukshetra, India for granting study leave and the Head, Dept. of Mathematics & Statistics, Banasthali University, Rajasthan, India for permitting the study facility. The second author would like to thank DST to carry out this research.

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