A COMPARATIVE STUDY TO EVALUATE THE EFFECTIVENESS OF COMPUTER ASSISTED INSTRUCTION (CAI) VERSUS CLASS ROOM LECTURE (CRL) FOR COMPUTER SCIENCE AT ICS LEVEL

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ABSTRACT

This study was aimed to evaluate the effectiveness of CAI vs. classroom lecture for computer science at ICS level. The objectives were to compare the learning effects of two groups with class room lecture and computer assisted instruction studying the same curriculum and the effects of CAI and CRL in terms of cognitive development. Hypothesis of this research were based on six levels of blooms taxonomy as there was one major hypothesis: There is no significant difference exist for CAI student in gaining a high cognitive achievement than students of same level having Traditional CRL. The study was delimited to three colleges of Faisalabad city. The research was true- experimental in nature. The research design followed by researcher is The Pre-test - Post test Equivalent groups Deign. The software used for CAI group was basically the combination of Discovery environment and simulation soft wares, however, the time for drilling and practice was given to student. It a designed to cover the all levels of cognitive domain described by B. S. Blooms (1956). A question paper containing 30 items multiple choice test was compiled from the curriculum, with a representative number of questions from each of the cognitive levels. Findings of this research indicate that total gain in cognitive domain by CAI was significantly superior to the total gain in cognitive domain by CRL teaching method. This study concluded that the skills of knowledge, analysis and synthesis assured significant increase. The CAI proved to be very much effective in increasing the evaluation and application skills of students to experimental group. Comprehension skill, however, not much affected by the CAI. According to the results of this study it was suggested that CAI as an effective teaching method should be applied to improve teaching quality and by using CAI it will be possible to eliminate lingual, regional and ethical biases between teacher and student.

Key words: computer assisted instructions, classroom lectures, cognitive domain,

INTRODUCTION

Computer Aided/Assisted Instruction (CAI) has existed for over four decades, but it was not widely used until the advent of the personal computer. CAI started making inroads in the workplace when network personal computers started becoming widespread in the late1980s.In early 90s CAI as an alternative to the traditional classroom training has been implemented by large businesses with robust instructional budgets, yet there remains a need for small to medium size employer to find an efficient method for delivering effective, reasonably priced instruction to their students.

CAI could benefit the human resources by opening up a greater number of training topics required for job advancement and provide new skills in using technology in the learning processes.

Initially, the use of computer-assisted instructional material (CAI) to enhance traditional teaching was a novel concept. However, increasing pressures at all levels of education perpetuated a need for time-efficient, effective teaching modalities that maintained the quality of teaching. CAI was considered to be a viable solution to these problems.

The studies do not provide conclusive evidence to support or reject the effectiveness of computer assisted instruction but were selected because of the similarities to this study. The objectives of the study were to examine the effect of computer-assisted instruction upon cognitive achievement and to measure the effectiveness in contrast of classroom lecture (CRL) method.

Computer Assisted Instruction (CAI).

CAI grew into greater favor in the mid-1990s, when the US Department of Labor-sponsored National Alliance of Business reported small and mid-sized companies should embrace new technologies such as CAI, so they may use technology to cause needed change; rather than reacting as technology changes affect them. Their report showed CAI can assist in increasing worker knowledge, as it can be designed to provide consistent training in new standards, such as the quality standard ISO 9000. They also reported benefits from the individualized pace

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of training, and a better ability to accommodate an increasingly diverse workforce (Bergman & Kaufmann, 1995).

Studies by Beth Wilson (1998), shows that thoughtfully designed computer software can present multiple, dynamically linked representation in ways that are impossible with static, inert media such as books and chalkboards. Some of the most fruitful applications of computer technology derive its capacity to present educationally powerful, dynamic visual images particularly in science and math.

CAI has the potential to serve a dual purpose by enhancing the learning experience for resident students, while opening the educational experience up to distance students (Brahler, 2005).

Bloom's Taxonomy
In an effort to explicate the specific intentions of our educational system, Benjamin S. Bloom (1956) and his colleagues published a Taxonomy of Educational Objectives" in the cognitive domain. According to him, the taxonomy is designed to be a classification of the student behaviors which represent the intended outcomes of the educational process (p. 12). His taxonomy consists of six major classes and their associated subclasses (see Figure: 1). These classes are arranged in hierarchical order from simple to complex. The most basic level, *knowledge*, is exemplified by the simple recall of information (e.g. specific facts, universals, methods, etc.). This process involves little more than bringing to mind the appropriate material (p. 201). At this level, the taxonomy refers only to the knowledge itself, not the utilization or application of this knowledge. The other levels in the taxonomy are distinguished from the first level as "intellectual abilities and skills." In other words, levels 2.00 to 6.20 require "organized modes of operation and generalized techniques for dealing with materials and problems".

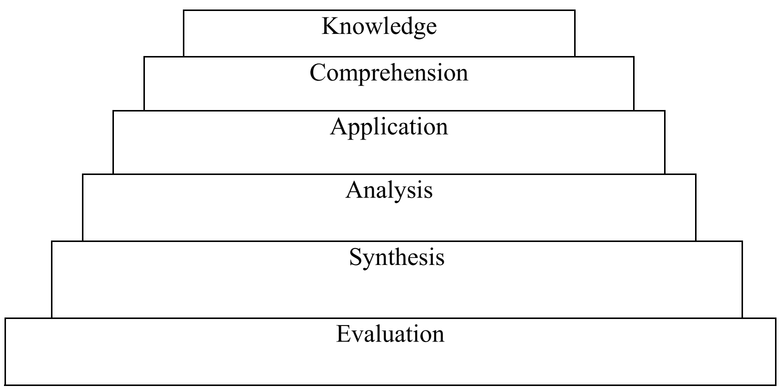

Figure 1 Six major classes /levels of Bloom's Taxonomy

Knowledge is the lowest level of intellectual ability and requires only that the student knows what is being communicated. With this fundamental understanding, the student is able to translate or rearrange the information without distorting its original meaning. In order to attain the next level; the student must be able to *apply* the appropriate abstraction (i.e. theory, principle, idea, or method) without being prompted.

Analysis implies the ability of a student to breakdown information into its constituent elements and to explicate the relationships between the various ideas expressed. This process is divided into three parts: analysis of elements, analysis of relationships, and analysis of organizational principles. In contrast to analysis, *synthesis* involves the process of putting together parts in order to form a whole, i.e. creating a novel pattern or structure. At this level, the student moves into the role of a "producer" (Jones, 1990).

The highest level within the cognitive domain, *evaluation*, requires that the student make both quantitative and qualitative judgments concerning the extent to which criteria are satisfied by certain materials or methods. Such evaluations are made on the basis of internal evidence (i.e. logical accuracy and consistency) or in terms of external criteria (i.e. a comparative process).

Computer-assisted Instruction and cognitive development
How can students be tested on the ability to function at the highest levels of Bloom's classificatory system using the MPC? In answering this question, delineation of several of the most common types of computer-assisted instruction (CAI) and their relation to the taxonomy will prove useful. (Scott D. Lipscomb, 2004).

Wright and Forcier (1985, p. 96) defined CAI as a learning environment characterized by instructional interaction between computer and student.... [The teacher] sets up the learning environment, ensures that each student has the necessary skills to engage in a particular cognitive activity, and adjusts the learning activities according to the students' needs.The instructional goal of the learning material may affect development time as well. Development time increases as the learning goals for the materials ascend bloom's learning taxonomy from knowledge to skill to attitude and as the technical complexity of the computer work increases from basic to intermediate, to high (Golas, 1993). Obviously many more hours would be required to develop an entire course.

Educational psychology provides many theoretical principles to be applied in the development and evaluation of computer assisted instructional technology. Milheim and Martin (1991) in studying learner control motivation, attribution and informational processing theory, identify learner control as an important variable in developing the pedagogy of soft wares.It is beneficial to generally maximize learner control as it increases the relevance of learning, expectations for success and general satisfaction contributing to heightened motivation (Keller & Knopp, 1997).

CAI software for cognitive domain

Many classifications of CAI available in market, six specific types by Spiro and Jehng (1990, pp. 163-205) seem to be most often utilized for educational purposes.

Drill and Practice instructional programs simply assist the student in remembering and utilizing information that the teacher has already presented, reinforcing previous learning through repetition. It is most important to improving knowledge level.

Tutorials are designed to introduce unfamiliar subject matter. The format of a computer tutorial often emulates a dialogue between the computer and the student, i.e. information is presented, questions are asked of the student and on the basis of the response given, a decision is made to move on to new material or review what has already been presented. These first two CAI types are most successful at improving the *knowledge* and *comprehension* levels of Bloom's taxonomy.

Instructional Games present course content in a competitive and entertaining manner, in an effort to maintain a high level of student interest. Though most frequently used to reinforce factual knowledge at the lower levels of the taxonomy, it is quite possible to create instructional games that demand application skills from all levels.

Simulations require the student to apply acquired knowledge to a novel situation. As a result, the student must analyze a presented scenario, make decisions based on the information given and determine a course of action. The simulated environment must change based on the course of action taken, presenting a significant challenge to the programmer. Successful performance relies on skills up to Bloom's level of analysis.

Problem-solving software requires the student to use high level cognitive abilities in the process of considering the problem at hand, analyzing the problem situation and its various solutions, predicting respective outcomes, determining which specific plan to attempt, and enacting the appropriate action(s) (Shute, 1993, p125). Well-designed software that fits this classification may require abilities from all levels of the taxonomy. However, perhaps the best way to have a student use abilities of synthesis is to have him/her create a novel hypertext system (Jones, 1990, p. 270). In this case, the student would be forced to identify relationships and evaluate all aspects of the chosen set of course materials. Evaluative ability can be tested (and improved) throughout programs representing any of these five types of CAI by prompting the student at significant times during the session and providing appropriate feedback or explanation.

Discovery-environment; in addition to the delineated types of CAI, it is also possible to provide a *discovery-environment* (Kendall, 1987, p. 192) within which the student is given a high level of freedom in determining the specific information presented during each session, as well as the order of presentation"(Spiro & Jehng, 1990).

Effects of CAI on Cognitive Achievement

Low technology methods of teaching use printed handouts and overhead transparencies. Overhead transparencies are primarily a labor saving device for classroom instruction. The teacher need not write the same information each time it is used. They allow easy presentation of color and graphics. The common attributes of print and overhead transparencies are affordability, reliability, flexibility, standardization of equipment, and ease of creation and use. However, they become unwieldy with large quantities of curriculum. They are static, and their distribution requires time and effort (Kearsley, 1990).

Television, videotape, and film have the advantage of ease of duplication and distribution to diverse audiences, but share a lack of interaction between the learner and the instructor. (Whetzel, 1996). Disadvantages to these formats also include high production cost, lack of involvement of local instructors, and learner boredom due to the lack of interaction (Kearsley, 1990).

Satellite training is a method of broadcasting curriculum to people in different locations simultaneously. Some systems have no feedback, some have audio feedback through a telephone line; which works well for question and answer periods. The feedback aspect solves some of the problems of one-way television broadcast. This system is suited for delivering consistent curriculum to widely scattered personnel, and is used by the postal service, the military and large financial corporations (Collis, Vingerhoets, & Moonen, 1997).

Teleconferencing consists of two-way communication. Audio-conferencing is a low cost, easily implemented system, and may be set up using existing telephone equipment. Videoconferencing is more technically challenging and requires more specialized equipment (Whetzel, D., Felker, D., & Williams, K. 1996). Computer conferencing uses existing computer equipment with the addition of microphones, but has been severely limited by bandwidth considerations (Kearsley, 1990).

CAI as an effective teaching method

Ebenezer S. O. Collier (2004) described that instruction supplemented by properly designed CAI is more effective than instruction without CAI. Computers can be used for text and test reading, games, tutorial, drill and practice, and simulation of laboratory experiments. Computer-assisted instruction can play an important role in classrooms and laboratory work not as substitute for other activities but as an additional tool.Cuoco and Goldenberg (1996) found in a mathematics curriculum that CAI offered the learner the ability to tinker with concepts in order to visualize results. Learners who could manipulate formulae, variables, and models independently using a CAI-based tool gained a better working knowledge of these concepts compared to learners listening to the same concepts presented by lecture. Bergman and Cheney (1996) found CAI increases learner knowledge when it involves the synergy of multiple senses. Learners were found to retain new knowledge better when the curriculum was presented with a combination of formats of text, sound, graphics and video.

A comparative study conducted in 1996 on frog dissection in a traditional lab and by a CAI simulation found users reported higher satisfaction levels using the simulation. While some of the satisfaction was due to the ability to perform a dissection without requiring an actual animal, users also reported satisfaction with the branching ability of the instruction, the ability to make their own choice on navigating the dissection, and the ability to back up and correct mistakes (Kinzie, Larsen, Burch, & Boker, 1996).When utilizing the CAI as a tutor, involving the student in the learning process interactively is of utmost importance. Computers are not constrained to the linearity evidenced in textbooks or earlier instructional software. The use of hypertext and hyper linking allows the student to determine his/her own presentation sequence, within limits established by the instructor and/or programmer (Scott D. Lipscomb, 2004).

The importance of maintaining the 'human interaction' component in an on-line teaching learning environment and CAI cannot be over-emphasized. Interactions between instructors and students, as well as peer interactions between students, are requisite to facilitating critical thinking and promoting enriched learning (McCormack & Jones, 1998).A major advantage of CAI is that, by necessity, it requires the student to be an active participant in the learning process. It is not only possible, but *necessary* for the student to interact with the computer or else nothing will happen (Chabay & Sherwood, 1992, p. 154). In order to progress from one screen of information to the next, in most cases, the student must respond using the computer's peripheral hardware (e.g. keyboard, mouse, joystick, or specially-designed devices). As a result, it is impossible for the student to assume the role of a mere observer (Lockard, Abrams, & Many., 1987, p. 144).

If an instructor, who uses structured CAI within a course, continues to hold traditional meeting sessions with students, the class rooms time can mature into an enriched experience which benefits students more by allowing more interaction between faculty and peers than in the traditional classrooms (Brooks, 1997).

In traditional classrooms settings, students and faculty often do not interact, rather they sit (as if separated by miles), and write downwards describing a linear presentation of materials. In the computer-assisted teaching model, students could access CAI materials during their course preparatory time, and class time could be reserved for conceptual discussions, peer interactions and mentoring. Rather than spending time making linear presentations of lecture material, instructors could implement creative teaching strategies in the classrooms (Porter, 1997).Time liberated by replacing the most didactic lectures with computer-delivered lectures may benefit faculty, students and universities in several ways for example; it may allow faculty time to facilitate more learner-centered activities by promoting interaction between peers and between students and faculty (Kommers, 1996, p.18).It is generally accepted that CAI has a higher development cost than CRL, but it can be recovered by use with a large number of users over time (Bergman & Cheney, 1996).

CAI represents a reduction of support in other areas, such as science research laboratories or resident teaching laboratories, for a couple of examples. Therefore, maximizing the effective use of resources and minimizing the cost of developing CAI, while still achieving instructional objectives, is crucial (Bui, 1999, p.14).

Mahmood (2004**)** conducted a study on CAI and traditional method of instruction. This study examined the effect of computer-assisted instruction on student achievement in general science as compared to traditional method of instruction. The result revealed that the experimental group out performed the control group in all achievement areas i.e. overall, by levels of cognitive domain and by type of content. Students like the CAI program and benefited from it. They found it better mode of instruction than the traditional method.

Barakter (2000) conducted a study, as quoted by Mahmood (2004), employing meta- analysis research approach. Purpose of this study was to determine whether CAI had an over all positive effects on students achievements in secondary and college level science education, when compared with traditional forms of instruction and to determine whether specific study or program characteristics were related to CAI effectiveness. Forty two studies comparing CAI and traditional instruction in science were included in this meta- analysis.The overall effect size was found to be 0.273 standard deviation, suggesting that CAI has a small positive effect on students' achievements in science education at college and secondary level. An average students exposed to CAI exceeded the performance of 62% of the students who were taught by using traditional instructional method.
Mintz (2000) and Campbell (2000), as quoted by Mahmood (2004), compared computerized and traditional instruction in the area of elementary Mathematics and elementary reading. It was found that there was significant difference in critical thinking skills between students who received CAI and students that did not.

A qualitative study aimed to ascertain the worth of CAI program for intermediate Algebra course was conducted by Miller (1999), as quoted by Mahmood (2004), The main point concerning CAI that emerges from this study was the benefits to students of immediate feed back from the computer. And the value of interaction as a means of learning Mathematics and the advantage of individualized instruction.

OBJECTIVES OF THE STUDY

The objectives were to compare the learning effects of two groups of learners studying the same curriculum. One group used traditional CRL; the other used CAI format instruction. The outcome was the ability to determine the relative feasibility of the two methods by comparing.

i. To compare the effects of CAI and CRL in terms of cognitive development.
ii. To illustrate the results of learner knowledge gained through CAI and CRL.
iii. To measure the development of comprehension skill by CAI and CRL.
iv. To analyze the effect of CAI and CRL on the application skills of students.
v. To take apart the effects of CAI and CRL with respect to analysis and synthesis skills of students.
vi. To assess the effectiveness of CAI to enhance learner's ability of evaluation in comparison of CRL.

HYPOTHESIS

H_0 There is no significant difference exist for CAI student in gaining a high cognitive achievement than students of same level having Traditional CRL
H_1 $_S$ignificant difference occur for learners using CAI acquire knowledge as effectively as learners in receipt of the same curriculum in a traditional CRL format
H_2 CAI students have a significant comprehension skill then traditional CRL students.
H_3 Significant difference existed in CAI's developmental ability of increasing application skills in students effectively then CRL.
H_4 CAI is significantly stronger by analysis and synthesis skill of students then CRL.
H_5 Evaluation skill is significantly better developed in students by CAI in comparison of CRL.

METHODOLOGY

Research Design

The research was *true- experimental* in nature because the equivalence of the control and experimental groups were provided by random assignment of subjects to experimental and control treatments. Both groups have average score 12 points something in pre-test. This showed the equivalence of the control and experimental groups. The research design followed by researcher i*s the Pre-test - Post test Equivalent groups Deign.*

Limitations and delimitations

i. No any test was conducted to select samples.
ii. Samples were selected by stratified sampling procedure.
iii. This study did not examine alternatives of CAI such as internet or distance learning.
iv. Computer use was limited to the presentation of curriculum only.
v. While computer-aided testing (CAT) is commercially available, it was not used in this study. Identical paper multiple-choice tests were used for both groups.
vi. The curriculum topic was limited to Microsoft Word and common hardware devices.
vii. The subjects of the study were limited to ICS (computer sciences).
viii. The sample included girls and boys as study subjects; average age of 18 years, of different ethnic backgrounds from two different colleges.
ix. Learners use Urdu as an instructional medium.
x. The curriculum was provided in Urdu. However, common terms and notion were used in English to maintain their correct impression.

Population

All students of computer science at ICS level from all colleges of Faisalabad are the population of this study. However, the researcher took the student from Govt. College of Science Faisalabad and Govt. College for Boys Samanabad, Faisalabad as the sample of the study.

Sample

This study surrounded the city of Faisalabad as the population of the study. The subject students of ICS level were selected at stratified basis. In order to get wide random samples, 20 students from each of the following neighbor colleges were selected for the said study:

- Govt. College for Boys, Samanabad, Faisalabad
- Govt. College of Science, Samanabad, Faisalabad

In order to avoid the institutional interference and pressures from experimental study, teacher, subject students and study results, the study was conducted in a third college having all well equipped CAI and CRL labs as follows:

- Oxford Textile and Computer College, Samanabad, Faisalabad ,

Pilot Test

A multiple choice question (MCQ) test containing 45 items was constructed and pilot tested, item analysis was done by measuring the (difficulty lever and item discrimination index) difficulty level from 0.5 to 0.7 considered the appropriate and discrimination index form 0.35 to 0.50 was considered .The items having the difficulty level and discrimination index below and above the mentioned range were discarded and 30 items were selected for final version of the test and reliability of the test was 0.827(Cronbach's Alpha).

Procedure of the Study

In order to avoid the inter personal and intra personal variation of two different teachers for CAI and CRL groups, it was decided to conduct the both classes by a single teacher having a competence to conduct both CAI and CRL instructions side by side on the same dates. Two designs of experimental curriculum were formed, one for CAI and other for CRL. The CAI format lessons were installed on the hard disks of the personal computers. Other applications on the personal computers, such as internet access and games, were removed or disabled. Before start of experiment, each subject student was introduced to the CAI format and they were familiar with hypertext, the navigation buttons, and the mouse and were able to navigate the lessons independently. A selected room with desks, chairs, paper, clock, and a white board was used for the CRL sessions.

The teachers delivered the material using the binder of CAI printouts as a script to equivalent the both formats. The white board was used as necessary to clarify difficult points. Subjects were encouraged to take notes and advised the notes could be used as reference material during the test. Subjects could ask questions as necessary, and review current and prior content as desired. A test containing 30 items multiple choice test was compiled from the curriculum, with a representative number of questions from each of the cognitive levels as given in (Table 1). The same test was given as a pretest to all subjects prior to beginning instruction.

Table 1. Cognitive parameters weight age of the test

Sr. No.	Parameter	Number of questions	% Weight age
1	Knowledge	9	30 %
2	Comprehension	5	16.6 %
3	Application	4	13.4 %
4	Analysis and synthesis	4	13.4 %
5	Evaluation	8	26.6 %

(All questions carried out equal marks)

The same test was used for evaluation at post-test stage. It was given to all subjects following completion of experimental study. Upon completion, the subjects were informed of their score and the incorrect answers were reviewed if requested. At this time, the pretest was also offered for review if requested.

Data Collection

Data was collected from both the groups by giving them a test consisted of 30 items, which was further subdivided into the parameters of cognitive domain.

Data Analysis

Collected data was tabulated and analyzed in terms of mean scores and two way analysis of variance followed by Dunkun Multiple Range Test (DMRT) was used as data analysis tool.

Findings

The findings drawn after the analysis are as under:

Table 2. Showing ANOVA on total cognitive achievement

Source of variation	DF	SS	MSS	F-Value	P-Value
Student	19	653.74	34.407	1.46 NS	0.1360
Teaching M	3	1743.44	581.146	24.79 **	0.0000
Error	57	1341.81	23.541		
Non-additivity	1	223.96	223.958	11.22	
Residual	56	1117.85	19.962		
Total	79	3738.99			

The results are given in table 2 the intra student variations were non-significant with very small F value. Both of the student groups obtained 12.5 to 20.1 marks in pre- experiment test but the variations were not significant. After the treatment, there was 60 % to 77 % increase in total cognitive achievement of students for CRL and CAI over control. In post experiment evaluation, however, there were no significant variations in 'acquiring of knowledge' by both CRL and CAI groups with respect to pre-test evaluation. The variations between two methods were highly significant with respect to other pre-fixed objectives.

Table 3. Showing ANOVA on total gain in knowledge

Source of variation	DF	SS	MSS	F. Value	Prob
Student	19	78.24	4.118	0.77 NS	0.7335
Teaching M	3	91.34	30.446	5.67**	0.0018
Error	57	305.91	5.367		
Non-additivity	1	29.88	29.880	6.06	
Residual	56	276.03	4.929		
Total	79	475.49			

The above table 3 shows that the intra student variations were non-significant with very small F value. Both of the student groups obtained 3.95 to 4.2 marks in pre- experiment test but the variations were not significant. After the treatment, there was 59 % to 45 % increase in *knowledge* of students for CRL and CAI over control. In post experiment evaluation, there were no significant variations in acquiring of knowledge by both CRL and CAI groups. The variations between two methods were highly significant with 5.67 F value.

Table 4. Showing ANOVA on total gain in comprehension

Source of variation	DF	SS	MSS	F- Value	P-value
Student	19	26.95	1.418	1.06 NS	0.4162
Teaching M	3	76.55	25.517	19.02**	0.0000
Error	57	76.45	1.341		
Non-additively	1	1.87	1.867	1.40	
Residual	56	74.58	1.332		
Total	79	179.95			

The above table 4 shows that the intra student variations were non-significant with very small F value. Both of the student groups obtained 1.9 to 4 marks in pre- experiment test but the variations were not significant. After the treatment, there was 110 % to 85 % increase in *comprehension* of students for CRL and CAI over control. In post experiment evaluation, there were no significant variations in acquiring of knowledge by both CRL and CAI groups. The variations between two methods were highly significant.

Table 5. Showing ANOVA on total gain in application

Source of variation	DF	SS	MSS	F. Value	P-value
Student	19	20.80	1.095	0.78 NS	0.7153
Teaching M	3	24.40	8.133	5.82**	0.0015
Error	57	79.60	1.396		
Non-additivity	1	10.55	10.547	8.55	
Residual	56	69.05	1.233		
Total	79	124.80			

The table 5 reveals that the intra student variations were non-significant with very low F value. Both of the student groups obtained 1.9 to 2.3 marks in pre- experiment test but the variations were not significant. After the treatment, there was 21% to 77 % increase in *application skill* of students for CRL and CAI over control. In post experiment evaluation, there were no significant variations in acquiring of knowledge by both CRL and CAI groups. The variations between two methods were highly significant.

Table 6. Showing ANOVA on total gain in analysis and synthesis

Source of variation	DF	SS	MSS	F. Value	P-value
Student	19	25.70	1.353	1.28 NS	0.2323
Teaching M	3	46.30	15.433	14.61 **	0.0000
Error	57	60.20	1.056		
Non-additivity	1	4.49	4.488	4.51	
Residual	56	55.71	0.995		
Total	79	132.20			

The table 6 shows that the intra student variations were non-significant with very small F value. Both of the student groups obtained 1.3 to 3.1 marks in pre- experiment test but the variations were not significant. After the treatment, there was 138% to 56 % increase in analysis and synthesis skill of students for CRL and CAI over control. In post experiment evaluation, there were no significant variations in acquiring of knowledge by both CRL and CAI groups. The variations between two methods were highly significant.

Table 7. Showing ANOVA on total gain in evaluation

Source of variation	DF	SS	MSS	F. Value	P-value
Student	19	47.44	2.497	1.02 NS	0.4503
Teaching M	3	132.74	44.246	18.14 **	0.0000
Error	57	139.01	2.439		
Non-additivity	1	13.67	13.672	6.11	
Residual	56	125.34	2.238		
Total	79	319.19			

The table 7 reveals that the intra student variations were non-significant with very small F value. Both of the student groups obtained 3.35 to 4.75 marks in pre- experiment test but the variations were not significant. After the treatment, there was 37% to 117 % increase in *evaluation skill* of students for CRL and CAI over control. In post experiment evaluation, there were no significant variations in acquiring of knowledge by both CRL and CAI groups. The variations between two methods were highly significant.

More Findings

The results showed that intra student groups' variation were non-significant in all cases. The student definitely gained in cognitive domain by both of the teaching method as shown by comparison of pre-test and post-test.

1. Total gain in cognitive domain by CAI was significantly superior to the total gain in cognitive domain by CRL teaching method.
2. The application of CAI teaching method to experimental group led to a highly significant increase in knowledge skill of students then students having CRL treatment.
3. Inter teaching method variations were non significant with respect to *comprehension*. Students significantly gained comprehension skill as observed in post- test compared to pre-test with the two methods respectively.
4. Post-experiment test of both groups showed significant lead of CAI (+77) compared to CRL (+21).
5. The gain of analysis and synthesis skill in post-test evaluation by CAI is 146% higher than CRL.
6. 80 % increase in evaluation skill of students of experimental group proved the extraordinary significance of CAI teaching method over CRL.

CONCLUSIONS

This study concluded that CAI proved to be significantly superior to the CRL. The skills of knowledge, analysis and synthesis assured significant increase. The CAI proved to be very much effective in increasing the evaluation and application skills of students to experimental group. Comprehension skill, however, not much affected by the CAI. There for students of experimental group was looking well motivated and ready to learn each day of experimental duration of CAI treatments than students of CRL treatments.

RECOMMENDATIONS

1. CAI as an effective teaching method may be applied to improve teaching quality.
2. CAI may use as a supplementary learning tool to teaching low I Q level students.
3. CAI may also be used effectively in teaching subjects in which simulation models can help improving cognitive abilities.
4. By using CAI it will be possible to eliminate lingual, regional and ethical biases between teacher and student.

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