The Impact of Computers with Peer Interaction on Learning Physics

S. KADHIRAVAN and V. SURESH
Directorate of Distance Education, Annamalai University, Annamalainagar, Tamil Nadu

Abstract: *The use of computers in education is revolutionizing both learning processes and instructional technology. Computers allow the development of interactive and individualized relations among the learners. The interactive computer based instruction influences the human thought in many ways. Children learn differently with computers when compared to the traditional teacher based instruction. Computers motivate children to learn collaboratively rather than to complete with other children. Computer as an educational tool is used to enhance learner's skill in academic subjects at all levels of education. Researchers have made it clear that computer assisted instruction is effective in many learning situations. An assessment of the effects of computers on learning is a complicated process since it involves human computer interaction. In this context, an attempt is made to find out the impact of different instructional strategies viz. Lecture Method (LM), Computer Assisted Instruction as individualized instructional strategy (CAI) and Computer Assisted Instruction with Peer Interaction (CAIPI) on the achievement of students in physics. It is found that CAIPI is the most effective instructional strategy in enhancing the achievement of students in physics. Further, it is observed that CAIPI is also effective in enhancing the retention of the learners in Physics. The results are discussed in this study.*

Introduction

The psychology of learning emphasizes the individualization of the instruction. The prime concern in this area was "Programmed Learning". The main objective of programmed learning is to provide individualized instruction to meet the special needs of the individual learners. To accomplish this objective, an efficient and flexible device that can store a massive amount of organized information and use a select portion to meet the needs of individual learners is needed. Computer serves this purpose effectively. Computer Assisted Instruction (CAI) is the natural outgrowth of applications of the principles of programmed learning.

In CAI, the computer itself will select and present the right type of programmed materials for a particular student with the help of teaching machine attached. If the data related to the individual's abilities are fed, then the student will learn the content which is most appropriate for him. Under computer assisted learning, the student even has the option of putting questions to the computer. There is no single instructional design methodology for developing a CAI program. Most of the literature on CAI enumerates a number of different types of instructional

Indian Journal of Open Learning, 2003, 12(1), 47-58
ISSN 0971-2690, Printed in India,

programmes under the broad category of CAI. The list of different types of CAI application includes games, simulations, problem solving, drill and practices and tutorial programs.

Coburn, et al. (1982) defined Computer Assisted Instruction as "Computer applications applied to traditional teaching method such as drill, tutorial, demonstration, simulation and instructional games". The teaching-learning process includes the presentation of information, guiding learners' interaction with the learning materials, their practice of the learning materials and testing their performance in the subject taught so as to offer a meaningful feedback both to the teacher and taught for the betterment on instructional process. The computer may serve any combination of the above said phases of instruction. Hence, it is evident that when computer is responsible for the total instruction, it is important that all the four phases be included in computer assisted instruction.

Peer-based Collaborative Interactions with Computers

Computer-based group instructions are emphasized due to the introduction of co-operative and collaborative learning environments. It was expected that the computer networked learning environment is likely to aid the students to demonstrate different psycho-social behaviour during collaborative interactions (Jehng, 1997). In a peer-based collaboration, learners work jointly on almost all parts and at most all stages of a task. This involves greater social interaction than any other method of interaction. In the collaborative learning environment, individuals having greater knowledge or expertise in the subject tend to dominate the learning environment. Researches reveal that collaborative learning approach is best suited for investigating the peer-based interaction with computers.

The peer-based collaborative learning is viewed as a process of knowledge co-construction in which the knowledge of respective subjects transforms to coverage (Roschelle, 1992). Collaborative learning in a situation requires team members to achieve shared understanding of action. Shared understanding is a form of negotiation in which team members successfully refine meaning until understanding is mutually acceptable. The intellectual process during collaborative learning involves partners from beginning to the end. This process has three different situations viz. communication, negotiation and consolidation. These three situations are differentiated in terms of the level of cognitive process carried out by the subject in a particular situation (Jehng, 1997).

A better understanding of the psycho social processes of peer based education may be gained by analyzing the conversation and interaction during learning activity. From research studies, it is clear that the psycho social behaviour during collaborative work can be determined by the degree to which collaborative partners perceive the social presence of others (Walther, 1992).

Peer-based collaborative learning is frequently used for pedagogical reasons with the goal of promoting effective learning of difficult and complex knowledge. Since most of the subject matter in Physics needs mental effort to understand such a tedious process may require the assistance of others and hence, in this study a concept of peer-based collaborative learning with computers has been taken into account.

Need for Alternative Strategies in Teaching Physics

The quality of education largely depends upon the quality of teachers and the teaching learning resources available for the system. In the developing countries, the main problem in enriching the teaching-learning process is the over-crowdedness of the classroom. The number of learners are very large and have diverse learning needs. On the other hand, the resources are so meagre that the objectives of the system become unrealisable and also time consuming, if the system depends entirely on traditional instruction.

The explosion of mass media in our information age provides varied sources of information to the society. The communication resources available, help the learners to absorb more information and vicarious experiences of many phenomena. In the last thirty years, the introduction of a wide variety of new instructional methods, techniques and curricula into education has contributed to the growing use of instructional media in the classroom.

The use of different media in science instruction has continued to grow as educators have been able to identify and understand the processes of the usefulness of the media for better understanding of science phenomena among the students. Physics being very complex in nature, needs high imaginative power with reasoning abilities on the part of the learners to grasp. It is evident that students with poor imaginative power found it difficult to understand some of the phenomena in Physics which require the help of mental pictures (Rangaraj, 1995). Hence, it is imperative to provide an alternative instructional strategy to teach Physics for a better understanding.

The alternative instructional strategies should fulfill the heterogeneous requirement of the learners. As review from literature, it is suggested that microcomputers be used as a tool for science teaching, particularly for Physics teaching. Further, it can also be used to study the memory related issues as well. Therefore, computers can be used to provide an alternative teaching method so as to enable the learners to understand Physics in a better way.

Objectives of the Study

The objectives of the study are stated as follows:

- To find out whether there is any difference among the three instructional strategies (viz. LM, CAI, and CAIPI) in terms of their effectiveness in enhancing the performance of students in Physics with different levels of cognition viz. knowledge, understanding and application.
- To develop syllabi based computer software packages for the selected units in physics at Higher Secondary Level.
- To evaluate the developed computer software packages from technical and pedagogical points of view.
- To find out whether there is any difference among the three instructional strategies in terms of their effectiveness in enhancing retention of the learners.
- To construct Criterion – Referenced Tests (CRT) in the content areas taught through different instructional strategies in the present study.

Hypotheses

The following hypothesis were formulated for this study:

- Learning through CAIPI will promote better achievement in Physics than the CAI and Lecture method.
- Learning through CAIPI will enhance the achievement of students in Physics with varying levels of difficulty.
- Learning Physics through CAIPI will facilitate the retention in student better than the CAI and lecture method.

Delimitations

The delimitations of the study are:

The homogeneity among the control and experimental groups was established on the basis of scores of students in the pre-test. The intervening variables such as anxiety, fatigue, motivation, attitude, personality and intelligence were not taken into consideration while establishing homogeneity among the control and experimental groups.

- Only five syllabi based CAI packages have been developed and utilized in this study.
- The study is limited to a sample size of 105 Higher Secondary Students.

Method

The present study adopted Quasi Experimental design. In order to test the hypothesis spelt out, "Pre-test, Pro-test, Non-equivalent Groups Design" were found to be relevant and appropriate. Three identical groups each of 35 eleventh standard students were formed on the basis of their scholastic achievement in Physics. One of the groups was identified as control group and the other two groups were treated as experimental groups. Conventional Lecture Method was adopted for the control group, while CAI as Individualised Instruction and Computer Assisted Instruction with Per Interaction were introduced as experimental interventions to the other two groups respectively.

Five syllabus-based computer software packages in tutorial mode in the selected content areas from the eleventh standard Physics (Laws of Motion, Wave Motion, Elasticity, semiconductors and Semiconductor Diode) had already been developed and evaluated. A separate pre-test was developed and administered to control the logistic effects since the experimentation was made in the middle of the academic year. All the three groups were taught the same content through the respective instructional strategy. Criterion-referenced tests were developed in the above mentioned five content areas and were used as post-tests. Retention test in the same content areas were also administered to all the three groups 30 days after the completion of the experiment.

Sample

The sample of this study consists of 105 eleventh standard students from three different schools. The schools are situated in Coimbatore city of Tamil Nadu. The schools are selected on the basis of the computer facilities available in their campus since the packages developed for this study require Windows-2000 based computer systems. Students from one of the three schools was treated as a control group while from other two schools were treated as experimental groups. The whole sample of this study comprises students from urban area with similar socio-economic status. They study in English medium classes with Mathematics, Physics, Chemistry and Computer Science as optional subject.

Tools used

The tools used in the study are as follows:

1. Five syllabi based Computer software Packages in the content area viz. Laws of Motion, Wave Motion, Elasticity, Semiconductors and Semiconductor Diode prescribed in the eleventh standard Physics syllabi were developed by the investigator. The packages were developed in Visual Basic. All the above said packages have been evaluated by computer experts, educationists and practicing teachers using the 'Courseware evaluation Proforma' developed by the investigator.
2. A separate test was developed in Physics and used as a pre-test, to assess the entry behaviour of the students. The pre-test contains 25 items in the multiple choice type. The test assesses the knowledge of the students at the tenth standard level.
3. Five objectives based criterion-referenced tests in the selected content areas were developed by the investigator. The items in the criterion-referenced tests are multiple choice type, testing the cognition of the subjects at different levels viz. Knowledge, Understanding and Application. In total, there were 78 items in all the five tests among which 35 items pertaining to knowledge, 27 items to understanding and 16 items for application. The reliability and validity indices of the tests have been established using appropriate procedures.

Instructional Strategies Used in the Study

Lecture Method (LM)

The Lecture Method is still one of the popular instructional strategies in Physics teaching. This method is teacher centred. But, this method is still useful to explain the equations in Physics and the cause and effect phenomena. It is a flexible method, since the teacher can adopt themselves to the subject matter, time limit, available apparatus and equipments at a very short notice. Student's attention and interest are captured by the teacher by the way of presentation, gestures, etc. Apart from all these factors, the physical environment of the classroom itself enhances the sense of security in the minds of the students providing them with group feeling, emotional attachment and social reinforcement which lead to expected levels of interaction and feedback in the Physics class. Hence, the lecture method which is still considered as one of the best and cheapest methods of teaching was adopted by the researcher for the control group.

CAI as Individualised Instructional Strategy

Computers are considered to be one of the most powerful sources in the flow of information. Computer Assisted Instructional packages are helpful for the learners in learning the lessons at their own pace. There are individual differences among the students and the CAI provides the instruction according to the ability of the individual learner. Instruction and instructional models of CAI prompt the individuals to move quickly and this motivates the learners to learn much faster. The CAI as an individualized instructional strategy was used as the experimental intervention to the experimental group-I.

CAI with Peer Interaction

Some areas of Physics need imagination on the part of the learners for a better understanding of the concepts to be learnt. CAI with its acknowledged potentialities may not be sufficient for learners to understand some difficult contents in Physics which require additional explanation. Psychology suggests that an individual will learn more effectively when he receives information through peer group interaction. Hence, it was decided to adopt the peer group interaction with CAI as another experimental intervention. The experimental group-II in the study involves CAI with peer group interaction.

Results and Discussion

From Table-1, it is found that there is a significant difference between the means of the control group and experimental groups.I and II at 0.01 level. It is also found that there is a significant difference between the experimental groups I and II at 0.01 levels. The total mean score of the experimental group II is found to be higher than that of the control group and experimental group I. Hence, it is concluded that among the three instructional strategies viz. LM, CAI and CAIPI, CAIPI is the most effective instructional strategy in terms of realizing the instructional objectives in Physics.

Table-1: Significance of difference between the means of control and experimental groups with regard to Achievement Scores as measured by the post-test in Physics

Sl. No.	Groups Compared	Cognitive Levels	M_1	σ_1	M_2	Σ_2	D	σD	't'
1.	Control	Knowledge	16.857	2.598	24.457	2.940	7.600	0.633	11.463*
	Group *vs*	Understanding	12.657	3.413	15.857	2.462	3.200	0.711	4.501*
	Experimental	Application	12.228	1.957	12.542	2.544	0.314	0.542	0.579NS
	Group I	Total	41.742	5.638	52.857	5.712	11.115	1.356	8.196*
2.	Control	Knowledge	16.857	2.598	26.714	2.824	9.857	0.648	15.211*
	Group *vs*	Understanding	12.657	3.413	19.257	2.511	6.600	0.716	9.217*
	Experimental	Application	12.228	1.957	13.600	1.607	1.372	0.428	3.205*
	Group II	Total	41.742	5.638	59.571	4.841	17.831	1.256	14.195*
3.	Control	Knowledge	24.457	2.940	26.714	2.824	2.257	0.689	3.275*
	Group I *vs*	Understanding	15.857	2.462	19.257	2.511	3.400	0.496	6.854*
	Experimental	Application	12.542	2.544	13.600	1.607	1.058	0.465	2.275NS
	Group II	Total	52.857	5.712	59.571	4.841	6.714	1.265	5.307*

$N_1 = N_2 = N_3 = 35$ *NS – Not Significant* **Significant at 0.01 level*

M_1 and M_2 signify total mean score in experimental group 1 and 2 respectively.

σ_1 and σ_2 signify standard deviation in experimental group 1 and 2 respectively.

The peer-based collaborative learning environments with computer can improve learning and cause students to demonstrate different problem-solving performances as compared to individualized learning (Jehng, 1997). This is evidently clear from

the achievement scores of the CAIPI group. It is quite interesting to note that the 't' value at the application level between the control group and experimental group I is not statistically significant. There is a difference between these groups but it is small. If the CAI is provided as individualized instructional strategy, there will be no chance for the students to discuss with their friends or clarify their doubts with their teachers. Therefore, there may not be a chance to apply their knowledge and to check themselves. This may be the reason for a lack of significant difference between the control group and the experimental group I with regard to their scores at the application level. But, in general, the total achievement scores differs significantly and hence show that CAI as individualized instructional strategy has more effect than the lecture method in realizing the instructional objectives in Physics.

The study by Kulik and Kulik (1991) state that CAI had a positive effect on learning over a broad range of study feature variables and this in turn raised the achievement of the student. The increase in achievement in CAI method is due to the more effective CAI materials. Hence, there is an increasing achievement in Physics of the CAI group than the control group. Further, research studies reveal that CAI is found to be effective in promoting achievement, compared to the lecture method in all academic subjects (Mahajan, 1994; Mahapatra, 1995; Rangaraj, 1995; Christman, 1997). This is evidently seen from the scores of the CAI group in the present study.

Similarly, there is no statistically significant difference between the experimental groups I and II with regard to the application scores in Physics. But, the mean score of the experimental group II is higher than the experimental group I. In the experimental group II, students studied the CAI material individually and also discussed with their peers whenever they had any doubt. This might have provided feedback to the students which in turn increased their understanding. It is obvious from the results of the experimental group II with regard to the application scores. It is seen that the total mean score of the experimental group II is comparatively higher than that of the experimental group I and hence we may state that CAIPI has a better effect than the CAI in realizing the instructional objectives in Physics. Studies on peer-based co-operative interaction with computers showed that students in co-operative environment tend to interact quite frequently over all with the group members and their interactions were primarily task related, collaborative and positive (Repman, 1989; Whyte, 1990). This may be the reason for the students of the CAIPI group to have higher score than the other two groups.

Competence is the art and craft of classroom instruction which requires mastery of many methods and modes of communication, information and influencing pupil's behaviour. Here, it is found that CAI as individualized instructional strategy has greater impact than the Lecture Method while CAIPI has the greatest impact among the instructional strategies in enhancing achievement of the students in Physics.

To establish the difficulty level of the different content areas in Physics instructed during experimentation, 30 post graduate teachers in Physics working in different schools situated in Coimbatore city were selected at random and requested to give their choice about the difficulty level of the different content areas. Based on expert opinion the items were classified as having high and low difficulty levels.

From Table-2, it is found that there is significant difference at 0.01 level among the total mean scores of LM, CAI and CAIPI groups. The total mean score of the CAI

group is found to be higher than that of LM. The same mean score of the CAIPI group is higher than that of the CAI group. Hence, it is concluded that among the three instructional strategies, CAIPI is the most effective one in terms of its effectiveness in realizing the instructional objectives in Physics in the context of the contents with low difficulty level. The most consistently found effect in a computer based learning environment is 'increase in motivation' and closely related constructs' (Schofield, 1996). This motivation related constructs may be helpful for the students to learn any task easily and effectively.

Table-2: Significance of difference between the means of control and experimental groups with regard to Achievement Scores in the context of the contents with Low difficulty level

Sl. No.	Groups Compared	Cognitive Levels	M	σ	M	σ	D	σD	't'
1.	Control	Knowledge	50.186	8.778	71.925	11.728	21.739	2.476	8.779*
	Group *vs*	Understanding	52.000	15.840	63.619	10.370	11.619	3.201	3.629*
	Experimental	Application	73.330	13.915	77.380	16.253	4.050	3.616	1.120NS
	Group I	Total	56.285	8.310	70.742	9.296	14.457	2.107	6.681*
2.	Control	Knowledge	50.186	8.778	79.378	9.315	29.192	2.163	13.496*
	Group *vs*	Understanding	52.000	15.840	73.330	11.491	21.330	3.307	6.449*
	Experimental	Application	73.330	13.915	82.380	11.746	9.050	3.078	2.940*
	Group II	Total	56.285	8.310	78.285	6.678	22.000	1.801	12.215*
3.	Control	Knowledge	71.925	11.728	79.378	9.315	7.453	2.531	2.944*
	Group I *vs*	Understanding	63.619	10.370	73.330	11.491	9.711	2.616	3.712*
	Experimental	Application	77.380	16.253	82.380	11.746	5.000	3.389	1.475NS
	Group II	Total	70.742	9.296	78.285	6.678	7.543	1.934	3.900*

$N_1 = N_2 = N_3 = 35$ *NS – Not Significant* **Significant at 0.01 level*

It is interesting to note that the difference between the control group and the experimental group I as well as that between the experimental groups I and II at application level is not statistically significant. Therefore, it is inferred that irrespective of the instructional strategies, the students apply their knowledge to solve the problem. This may be the reason why the difference does not exist between these groups with regard to the application scores. But, at the total level the groups significantly differ in their effectiveness in realizing the instructional objectives in Physics in the context of the contents with low difficulty level.

Similarly, from Table-3, it is found that in the context of contents with high difficulty level, there is significant difference at 0.01 level among the total mean scores of LM, CAI and CAIPI groups. The total mean score of CAIPI is found to be higher than that of CAI. The same mean score of CAI is higher than that of LM. Hence, it is concluded that among the three instructional strategies CAIPI is the most effective instructional strategy in terms of its effectiveness in realizing the instructional objectives in Physics in the context of the contents with high difficulty level. In the CAIPI group, there is more opportunity for face-to-face peer interaction. The communication and cohesiveness existing among the members of the group may lead to the development of a quick problem-solving capacity (Jehng, 1997). This enables the learner to learn the high difficulty level content effectively.

It is quite obvious to note that the difference among the three groups with regard to the score at application level is not statistically significant, as in the case of contents with low difficulty level. It is interesting to note that the difference between the mean

scores of the experimental groups I and II with regard to knowledge is not statistically significant whereas at the understanding level, the mean difference is significant. Johnson and Johnson (1984) stated that quality of daily achievement, factual recognition, application and problem-solving text items are more effective than computer-assisted competitive and individualistic learning environments. It is evident that CAIPI provides better understanding to the student since, the students of this group had more chances to interact with their peers and gained guidance. It might have in turn increased the understanding of the students. At the total level, the groups significantly differ in their effectiveness in the context of the content with high difficulty level. This study supports the claim that in a computer-based collaborative learning environment, students are able to develop better the complex problem-solving skills than the others.

Table-3: Significance of difference between the means of control and experimental groups with regard to Achievement Scores in the context of the contents with High difficulty level

Sl. No.	Groups Compared	Cognitive Levels	M_1	Σ_1	M_2	σ_2	D	σD	't'
1.	Control	Knowledge	44.285	10.497	65.952	11.507	21.667	2.632	8.232*
	Group *vs*	Understanding	40.476	13.821	52.619	13.768	12.143	3.297	3.683*
	Experimental	Application	85.714	20.076	81.428	21.829	4.286	5.012	0.855NS
	Group I	Total	48.571	7.833	62.448	8.928	13.877	2.007	6.914*
2.	Control	Knowledge	44.285	10.497	70.476	13.114	26.191	2.839	9.225*
	Group *vs*	Understanding	40.476	13.821	68.809	14.684	28.333	3.408	8.313*
	Experimental	Application	85.714	20.076	92.857	15.319	7.143	4.268	1.673NS
	Group II	Total	48.571	7.833	72.959	9.006	24.388	2.017	12.091*
3.	Control	Knowledge	65.952	11.507	70.476	13.114	4.524	2.949	1.543NS
	Group I *vs*	Understanding	52.619	13.768	68.809	14.684	16.190	3.402	4.758*
	Experimental	Application	81.428	21.829	92.857	15.319	11.429	4.507	2.535NS
	Group II	Total	62.448	8.928	72.959	9.006	10.511	2.143	4.904*

$N_1 = N_2 = N_3 = 35$ *NS – Not Significant* **Significant at 0.01 level*

It is concluded that there is a significant difference among the instructional strategies viz. LM, CAI and CAIPI in terms of their effectiveness in realizing the instructional objectives in Physics in the context of contents with varying difficulty levels.

From the results, we can state that CAIPI is more effective when compared to CAI as individualized instructional strategy and lecture method in modifying the irrespective of the difficulty level of the content. Also, CAI is more effective than lecture method in modifying the cognition of the students at knowledge, understanding and total levels irrespective of the difficulty level of the content.

From Table-4, it is found that there are significant differences at 0.01 level between the means of the control and experimental groups and between the experimental groups I and II at all levels of cognition viz. knowledge, understanding, application and total. The mean score of the CAIPI are found to be more than that of the other two groups. The mean score of the CAI group are found to be more than that of the lecture method at all levels of cognition. Hence, it is concluded that CAIPI is more effective when compared to the lecture method and CAI in enhancing the retention at knowledge, understanding, application levels and total score in Physics. The effectiveness of feedback is a basic component of instructional theory that has been demonstrated by many researchers. Frequent and consistent use of feedback is widely recommended in any instructional strategy. Studies also reveal that although feedback seems to be an important element for learning enhancement and retention,

it is true only under certain condition (Myint, 1997). In the present study, CAIPI is found to be the most effective instructional strategy in enhancing the students' retention in which there is more opportunity for shared understanding as well as for meaningful feedback.

Table-4: Significance of difference between the means of control and experimental groups with regard to Achievement Scores as measured by the Retention test in Physics

Sl. No.	Groups Compared	Cognitive Levels	M_1	σ_1	M_2	Σ_2	D	σD	't'
1.	Control	Knowledge	10.400	1.438	19.114	2.795	8.714	0.531	16.410*
	Group vs	Understanding	6.571	1.941	12.028	2.443	5.457	0.527	10.354*
	Experimental	Application	7.314	2.081	9.171	2.035	1.857	0.491	3.782*
	Group I	Total	24.371	3.696	40.314	4.214	15.943	0.947	16.835*
2.	Control	Knowledge	10.400	1.438	23.200	2.605	12.800	0.503	25.447*
	Group vs	Understanding	6.571	1.941	15.114	2.327	8.543	0.512	16.685*
	Experimental	Application	7.314	2.081	11.228	1.883	3.914	0.474	8.257*
	Group II	Total	24.371	3.696	49.543	3.706	25.172	0.884	28.475*
3.	Control	Knowledge	19.114	2.795	23.200	2.605	4.086	0.645	6.334*
	Group I vs	Understanding	12.028	2.443	15.114	2.327	3.086	0.570	5.414*
	Experimental	Application	9.171	2.035	11.228	1.883	2.057	0.468	4.395*
	Group II	Total	40.314	4.214	49.543	3.706	9.229	0.948	9.735*

$N_1 = N_2 = N_3 = 35$ **Significant at 0.01 level*

It is quite interesting to note that at application level there is a significant difference between the means of control and experimental groups which is not observed in the case of the scores of post-test. From Table-4, we infer that the lecture method is the least effective method in enhancing the retention power whereas the CAI and CAIPI strategies are more effective in retrieving the information. Instructional treatments which use a visual mode of presentation (Richard and Sadler-Smith, 1992). Such kind of materials will be in memory for a longer time and can be retrieved easily. This is evidently seen from the score of the CAI and CAIPI groups in which the visual presentation was provided through computer.

Among the three instructional strategies, CAIPI is found to be most effective in enhancing the retention power at all levels of cognition. Psychological studies about effective learning emphasize the importance of first hand concrete experience involving sensory contacts as the starting point of learning, which later proceeds toward greater abstraction. A pupil profits most from instruction when he/she becomes involved through his own interests and purpose and such an involvement is possible when concepts and principles are introduced to him/her through well-chosen educational media appealing to different senses. Such a pupil will also act creatively. In the CAIPI group, students had a chance for these experiences and also they had been provided with peer assistance. In a peer discourse, students can find a direct relationship with a real audience from which they can get meaningful feedback. Students can experiment and construct new understanding and ideas in a peer discourse (Ruberg, et al. 1996) which enhances retention. These may be the reasons that CAIPI method has greater impact than the other two strategies in enhancing the retention power in Physics.

Conclusion

This study reveals that computer assisted instruction with peer interaction is the most effective instructional strategy among the three strategies compared. This has implication for teaching as well as learning. The teachers may try to provide opportunities for peer interactions during the process of learning Science. This would

enhance the understanding of the subject matter as well as the psycho social climate for learning. Interaction among peers not only enhances motivation to learn but, also communication appropriate for their level. In a peer based interactions students learn from one another. Moreover, students can share their special alternative view points, additional insights, audience feedback and evaluation. These kinds of human interactions increase the shared understanding as well as the retention capacity of the students. Keeping these things in mind educators should make use of the latest technological advancements to enhance learning among students at various levels in schools.

References

Christman, E. et al. (1997) Progressive comparison of the effects of computer-assisted instruction on the academic achievement of the secondary students, *Journal of Research on Computing in Education*, 29, 32-337.

Coburn, et al. (1982) Practical guide to Computers in Education – Mass: Addition – Wesley Publishing Co.

Jehng, J. (1997) The psycho-social processes and cognitive interactions with computers, *Journal of Educational Computing Research*, 17, 19-46.

Johnson, D.W. and Johnson, R.J. (1984) Co-operative small-group learning, Curriculum Report, 14, 12-18.

Kadhiravan, S. (1999) Effectiveness of computer assisted instruction in relation to students use of self – regulated learning strategies, Ph.D Dissertation, Bharthiar University, Coimbatore.

Mahajan, S.L. (1994) Effectiveness of Computer-assisted instruction for teaching singular and plural at II grade, Bhartiya Shiksha Shoodh Patika, 13, 29-32.

Mahapatra, B.C. (1995) Development of software package for teaching chemistry to class IX students of Madhya Pradesh state, *Indian Educational Abstracts*, New Delhi: NCBRT – 23.

Myint, Swe Khine (1997) The role of feedback in utilization of multimedia courseware Staff and Educational Development International, 1, 79-85.

Rangaraj, K.R. (1995) Effectiveness of computer assisted instruction in teaching Physics at Higher Secondary Stage Ph.D Dissertation, Bhararthiar University, Coimbatore.

Repman, J.L. (1989) Cognitive and affective outcomes of varying levels of structured collaboration in a computer-based learning environment, *DAI*, 51, 485-A.

Richard, Riding & Sadler – Smith (1992) Type of instructional materials, cognitive style and learning performance, *Journal of Educational Studies*, 18, 323-339.

Roschelle, J. (1992) Learning by collaborating: Convergent conceptual stage, *The Journal of Learning Science*, 235-276.

Ruberg, et al. (1996) Student participation, interaction and regulation in a computer-mediated communication environment: A qualitative study, *Journal of Educational Computing Research*, 14, 243-268.

Schofield, J.W. (1996) Computers and classroom social possesses – A Review of the Literature, Social Science Computer Review, 15, 27-39.

Walther, J.B. (1992) Interpersonal effects in computer-mediated interaction, Communication Research, 19, 52-90.

White, Michael (1990) Individualistic vs paired/Co-operative computer assisted instruction: Matching instructional method with cognitive style, *DAI*, 51, 2720-A.

Dr. S. Kadhiravan is Lecturer in Psychology in the Directorate of Distance Education, Annamalai University.

Dr. V. Suresh is Professor of Psychology in the Directorate of Distance Education, Annamalai University.