CHAPTER VI

AN OVERVIEW OF THE STUDY
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CHAPTER VI
AN OVERVIEW OF THE STUDY

INTRODUCTION

We are at the threshold of a new era which presents momentous changes in the modalities of education. The conventional practices are fast disappearing and this place is substituted by many new scientific instructional practices. Ours is an age of science and technology. As a matter of fact, science and technology have become elements of our culture and perhaps the most effective factors of development. Hence there is an ever-increasing impact on society.

EDUCATIONAL TECHNOLOGY

Educational Technology is a system in education in which machines, materials, media, men and methods are interrelated and work together for the fulfillment of educational objectives. Educational Technology is a "rational problem solving approach to education, a way of thinking skeptically and systematically about learning and teaching".

Educational Technology can be considered as the systematic use of scientific methods to plan, realise and evaluate effective teaching - learning process in formal and non-formal situations. The proper selection and use of educational media help the teachers to arrange more effective environment for teaching and learning. Educational Technology principles are applicable to all topics and subjects and hence forms a basis to all curriculum development. Educational Technology involves the process and product dimensions of providing quality education to enhance improved performance.

NEED FOR EDUCATIONAL TECHNOLOGY IN BIOLOGY TEACHING

Educational Technology has been regarded as an integral part of the whole teaching-learning process. The role of the teacher in a classroom is still significant, but he
has to acquire and promote new methods to become more relevant and easy. It can also help to overcome the difficulties such as lack of verbalising faced in the classroom, to improve the quality of education. The audio-visual aids are improving the teaching and making learning more effective.

Educational Technology is a tool at the hands of a teacher in the classroom teaching. With the advent of science and technology the task of the teacher is more easy and the learning is more effective. Due to scientific development and technological improvements a monumental amount of educational technology devices have been invented. These devices have changed many activities in classroom teaching, especially in Biology. Computers pave a fruitful way for the study of Biology. For effective Biology teaching colourful diagrams, specimens, etc. are needed in classroom. These materials can be effectively used by computers. Teaching through computer makes the learners more equipped.

COMPUTER - ASSISTED INSTRUCTION (CAI)

Computers play an important role in enhancing the efficiency of teaching-learning process, making the children more creative and providing them with an individualized environment. It is quite a jump from traditional teaching reliance on text books to the computer use. Computers expose students to the modern technology while inculcating in them a new and scientific approach to learning.

Learning takes place in many ways. Some times it is intentional as the students acquire information presented in the classroom or when they look upon some types of media. An individualized learning that has been receiving a great deal of attention in recent years is Computer Assisted Instruction (CAI).

CAI is a refinement of the concept of Programmed Instruction which was introduced by S.L.Pressey (1926) and refined by B.F.Skinner in the 1954's. CAI marvels
have been demonstrated and seem to revolutionize the whole spectrum of education. It has more flexibility and versatility than any of the teaching machines. CAI helps education in planning instruction and providing relevant material. CAI provides all students with appropriate levels of instruction. Various instructional modes that the Computer Assisted Instruction can facilitate most effectively are Tutorial, Drill & Practice and Simulation.

INSTRUCTIONAL MODES OF CAI

(i) Tutorial

This mode attempts to put the computer into the role of a teacher instructing an individual learner. Two factors to be considered in a tutorial are pedagogics and didactics. Pedagogic factors involve the overall teaching approach. Didactics involve in making decision as to what and when to teach and not reteach the same point without having given the student a chance to absorb the new material and not repeating the same topic by mistake. Tutorials are useful in learning the concepts. It provides links to prior learning and it also involves ample opportunities for the learners to develop connective networks through examples and questions.

(ii) Drill & Practice

Drill & Practice is one of the most important modes of CAI. There are selected facts, concepts and generalization that students need to review in Science. Vital subject matter only should be emphasized within the frame work of Drill & Practice. It allow the students to move at their own pace and with immediate feed back. Drill & Practice are efficient skill builders. These programmes afford additional review in a highly motivational and interactive format. It has its own advantage over the learners, since it masters the skill thoroughly. This CAI mode provides the instruction according to the ability of the learner.
(iii) Simulation

Simulation experiences are significant in the Science curriculum. Computerized Simulation are models or imitations of processes. Simulations expand and enhance classroom experiences. Attempts are made to have learners' experience be real in a simulated form. Simulation mode is not meant to replace actual hands-on experience, it is used as an extension of other classroom activity. Simulation, when used properly the courseware has the same potentiality to help students gain a better understanding of ideas.

CAI modes have several advantages of instruction over Conventional Lecture Method. The learner has immediate feedback about whether he/she understands the material. The learner reviews only the material he/she does not understand. There is constant incentive to learn because of many positive reinforcements. This method also avoids aversive aspects of classroom learning. The student can progress at an individual rate, depending on how well, rather than how fast he/she learns.

NEED FOR THE STUDY

Due to poor imaginative power, some students particularly the average and the slow learners find difficulties in understanding some concepts in Biology which require them to form some mental pictures. 'Cell Division' in Cytology of the Biology syllabus is one such area which challenges the average and slow learners. Unless some device is made, these pupils cannot comprehend the concept in the said content area. Hence, it is the duty of the Biology teacher to devise an instructional strategy which would support him in realising the envisaged instructional objectives. Here comes the Educational Technology particularly the 'Computer Technology' in teaching to rescue the Biology teacher from the said crisis.

Relatively a few studies measuring the effects of CAI on learning particularly Biology as a subject at school level exist at the international level. Most of these studies concentrate on cognitive effect of pupils as an outcome of computer application in
teaching. Some studies show significant gain in problem solving skills, including gains in divergent and reflective thinking. Recent studies suggest that several aspects of modern Tutorial software could make the subject matter intrinsically, some other studies indicate that motivation to learn particular subjects can be increased by using computers.

Under these circumstances the present study assumes importance in exploring the unexplored potentialities of computer based instruction in different modes viz. Tutorial, Drill and Practice and Simulation as a tool in solving the problems faced by the Biology teachers and how the media effectiveness is influenced by the learner personality.

STATEMENT OF THE PROBLEM

So far there has been no conclusive evidence that the computer is a positive educational force, worth an enormous investment in hardware, software and teacher training. Research studies suggest that low achievers have greater cognitive and affective gains with computer based application when compared to high achievers. It is unfortunate that there is no conceptual framework existing to evaluate the relevance of results obtained in a computer saturated environment compared to those obtained in computer scarce ones. It is important to ascertain whether CAI is effective in different cultural contexts and in different subjects at different educational levels in the context of different socio-cultural settings. Keeping all these points in mind the present study on "Relative Effectiveness Among Different Modes of Computer Based Instruction in Relation to Students’ Personality Traits" was taken up by the investigator.

SCOPE OF THE STUDY

The research in the area of computer based instruction in the teaching-learning process at all the levels of education would help decision makers to face the new challenges arising from the increased use of computers in the modern society. In line with the same sentiments the present study establishes the relative effectiveness among different modes of
computer based instruction viz. Tutorial, Drill & Practice and Simulation in realising the instructional objectives in teaching Biology at Higher Secondary Stage. In conjunction with other process product study this studies contributes to the knowledge of computer based instruction. The specially developed CAI packages in teaching Biology would be an eye opener for the practicing teachers so that they can direct their attention with a view to solving the practical difficulties in teaching such a challenging content area like "Cell Division".

OBJECTIVES OF THE STUDY

The objectives of the study are stated as follows:

1. To find out whether there is any significant difference between the Conventional Lecture Method (CLM) and the Computer Assisted Instruction (CAI) as an Individualised Instructional Strategy in terms of their effectiveness in realising the instructional objectives in Biology at Std. XI.

2. To establish the relative effectiveness among the different modes of Computer Based Instruction viz. Tutorial, Drill & Practice and Simulation in realising the instructional objectives in Biology at Std. XI.

3. To find out whether there is any significant difference between the Conventional Lecture Method (CLM) and the Computer Assisted Instruction (CAI) as an Individualised Instructional Strategy in terms of their effectiveness in enhancing the retention of cognition as revealed by the learners' performance in the retention test.

4. To find out whether there is any significant difference among the different modes of Computer Based Instruction viz. Tutorial, Drill & Practice and Simulation in terms of their effectiveness in enhancing the retention of cognition as revealed by the learners' performance in the retention test.
5. To develop syllabus based Computer Assisted Instructional Packages in different 
   modes viz. Tutorial, Drill & Practice and Simulation for teaching Biology at Std. XI.

6. To validate the developed CAI packages from technical and pedagogical points of view.

7. To develop a Criterion Referenced Test (CRT) in the content areas being instructed to 
   the subjects of Control and Experimental Groups.

8. To assess the personality of the subjects of the Control and Experimental Groups 
   using Cattells' 16 P.F. Inventory with a view to study whether it has any influence on 
   the media effectiveness in realising the instructional objectives.

**HYPOTHESES OF THE STUDY**

The hypotheses of the study are stated as follows:

1. There is significant difference between the Conventional Lecture Method and 
   Computer Assisted Instruction as an Individualized Instructional Strategy in terms of 
   their effectiveness in realising the instructional objectives in Biology at Std. XI.

2. There is significant difference among the different modes of Computer Based 
   Instruction viz. Tutorial, Drill & Practice and Simulation in realising the instructional 
   objectives in Biology at Std. XI.

3. The effectiveness of different instructional strategies viz. Conventional Lecture 
   Method and Computer Assisted Instruction in different modes Viz. Tutorial, Drill & 
   Practice and Simulation in realising the instructional objectives is influenced by the 
   learners' personality traits.

4. There is significant difference between the Conventional Lecture Method and 
   Computer Assisted Instruction in different modes viz. Tutorial, Drill & Practice and 
   Simulation in realising the instructional objectives in the context of the learners' with 
   varying levels of personality traits.
5. There is significant difference among the different modes of Computer Based Instruction viz. Tutorial, Drill & Practice and Simulation in realising the instructional objectives in the context of the learners' with varying levels of personality traits.

6. There is significant difference between the Conventional Lecture Method and Computer Assisted Instruction in different modes viz. Tutorial, Drill & Practice and Simulation in terms of their effectiveness in enhancing the retention of cognition as measured by the learners' performance in the retention test.

7. There is significant difference among different modes of Computer Based Instruction in terms of their effectiveness in enhancing the retention of cognition as measured by the learners' performance in the retention test.

TOOLS USED IN THE STUDY

The tools used in the study are as follows:

1. Nine syllabus based computer software packages were developed in Visual Basic by the investigator in three different modes of CAI viz. Tutorial, Drill & Practice and Simulation in the content area unit 'Cell Division' (i) Mitosis (ii) Meiosis - I and (iii) Meiosis – II prescribed for XI Std. in Biology.

2. A separate pretest was developed by the investigator to access the cognition of the students in Biology at Std. X in order to establish the identity among the control and the experimental groups in terms of the subjects' entry behaviour in Biology.

3. Three objective based objective type tests (CRTs) in the selected content areas were developed by the investigator as post-test and retention test to assess the terminal behaviour of the students who formed as the subjects for the experiment. The items in the Criterion Referenced Tests are of multiple choice type testing the cognition of the
subjects at different levels viz. Knowledge, Understanding and Application. In total, there are 100 items in all the three tests taken together with a break up of 36 knowledge level items, 45 understanding level items and 19 application level items. The reliability and validity estimates of the tests have also been established using appropriate procedures.

4. 16 P.F. Inventory 'Form D' developed by Raymond B. Cattell was used to access the personality of the subjects of the control and the experimental groups with a view to study whether it has any influence on the media effectiveness.

METHODOLOGY IN BRIEF

The present study adopts the Quasi Experimental Design. In order to test the hypotheses spelt out "Pre-test, Post-test Non-equivalent Groups Design" was found to be most relevant and appropriate. Four groups each of 35 to 50 students studying at Std. XI in four different schools were formed. One of the groups was identified as control group while the other three groups were treated as experimental groups. Conventional Lecture Method was adopted for the control group, while CAI as individualized instruction in different modes viz. Tutorial, Drill & Practice and Simulation were introduced as experimental interventions to the other three groups.

Nine syllabus-based computer software packages in different modes of CAI viz. Tutorial, Drill & Practice and Simulation in the content area unit 'Cell Division', viz. (i) Mitosis, (ii) Meiosis – I and (iii) Meiosis – II prescribed in Biology for Std. XI 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 four groups were taught the same contents through the respective instructional strategy. Criterion Referenced Tests (CRTs) were developed in the said content areas and were used as post-tests.
To assess the students' personality, Cattells' 16 P.F. Inventory was administered to the control and the experimental groups with a view to establishing the influence of learners' personality on media effectiveness. The same CRTs were once again administered to the control and the experimental groups as retention test one month after the experimentation was over.

The responses made by the subjects of the control and the experimental groups to the different measuring instruments were scored, tabulated and analysed using appropriate statistical techniques.

**DELIMITATIONS OF THE STUDY**

The delimitations of the study are as follows:

1. The homogeneity among the control and the experimental groups was established only with respect to the scores as measured by the pre-test in Biology syllabus prescribed for Std X.

2. Due to vastness of the syllabus, it was not possible for the investigator to develop the packages for the whole syllabus prescribed for XI Std in Biology. Hence, only one unit viz. CELL DIVISION was selected as the instructional content in the present experiment.

3. For want of time and availability of computer facility, the study was confined only to four schools in the Coimbatore city with the sample size ranging from 35 to 50 for each school.

**MAJOR FINDINGS AND CONCLUSIONS OF THE STUDY**

The major findings and conclusions of the study are stated as follows:

1. It is found that there is significant difference at 0.05 level between the means of the control group and the experimental groups II and III on the scores as measured by the post-test at all levels of cognition. The mean values of the experimental
groups II and III were found to be greater than that of the control group. However, there is no significant difference between the means of the control group and the experimental group I.

Hence, it is concluded that different modes of computer based instruction viz., Drill & Practice and Simulation are more effective when compared to Conventional Lecture Method in realising the instructional objectives in Biology at Std. XI. However, the Conventional Lecture Method and Tutorial as one of the modes of computer based instruction are equally effective in realising the instructional objectives.

2. There is significant difference at 0.01 level between the means of the experimental group I and the experimental group II on the scores as measured by the post-test at all levels of cognition. The mean values of the experimental group II were found to be greater than that of the experimental group I. Again, it is found that there is significant difference between the means of the experimental group I and the experimental group III at all levels of cognition except at knowledge level. The mean values of the experimental group III were found to be greater than that of the experimental group I. Again it is found that there is significant difference between the means of the experimental group II and the experimental group III at all levels of cognition except at knowledge and understanding levels. The mean values of experimental group II were found to be greater than that of the experimental group III.

Hence, it is concluded that Drill & Practice as one of the modes of computer based instruction is the most effective one while Tutorial is the least effective one in realising the instructional objectives in Biology at Std XI. However, Simulation mode stands between the Tutorial and Drill & Practice in terms of its effectiveness in this respect.
3. It is found that there is no significant difference between the High Range Scorers and Low Range Scorers grouped based on the sten scores of the second order personality factors viz. Extroversion, Anxiety, Tough Poise and Independence with regard to the scores on the post-test for the control and the experimental groups.

Hence, it is concluded that the effectiveness of the Conventional Lecture Method and the different modes of the Computer Based Instruction viz. Tutorial, Drill & Practice and Simulation is not influenced by the learners' personality. It is evident that the media effectiveness is independent of learners' personality in achieving the instructional objectives.

4. It is found that there is significant difference at 0.05 level between the means of the control group and the experimental group II on the scores as measured by the post test in the case of all the four second order personality factors for the low range scorers grouped based on the sten scores as measured by the Cattell's 16 PF inventory. The mean values of the experimental group II were found to be greater than that of the control group in the case of all the four second order personality factors. It is also found that there is no significant difference between the means of the control group and the experimental group III on the scores as measured by the post test in the case of all the four second order personality factors except "Anxiety". It is again found that there is no significant difference between the means of the control group and the experimental group I on the scores as measured by the post test in the case of all the four second order personality factors.

Hence it is concluded that CBI in Drill & Practice and Simulation modes are more effective when compared to the Conventional Lecture Method in the case of him who is shy, self-sufficient and inhibited in interpersonal contacts; whose life is generally satisfying and is able to achieve those things that seem to him to be important; to be
troubled by pervasive emotionality, and may be of a discouraged, frustrated type and a group dependent, chastened and a passive personality. But at the same time, the Conventional Lecture Method and CBI in Tutorial mode are almost equal for him who is having the same personality features in their effectiveness in realising the instructional objectives.

It is again found that there is significant difference at 0.05 level between the means of the control group and the experimental groups II & III on the scores as measured by the post test in the case of High Range Scorers for all the four second order personality factors. The mean values of the experimental groups II and III were found to be greater than the mean values of the control group. It is also found that there is no significant difference between the control group and the experimental group I on the scores as measured by the post test in the case of all the four second order personality factors.

Hence, it is concluded that CBI in Drill & Practice and Simulation modes are more effective in terms of their effectiveness in realising the instructional objectives for him who is socially outgoing, uninhibited person, good at making and maintaining interpersonal contacts; high on anxiety, dissatisfied with the degree to which he is able to meet the demands of life and to achieve what he desires; to be an enterprising, decisive and resilient personality; an aggressive, independent, daring and incisive person. But at the same time Conventional Lecture Method and CBI in Tutorial mode are almost equal for him who is having the same personality features in their effectiveness in realising the instructional objectives.

5. It is found that there is significant difference at 0.01 level between the means of the experimental group I and the experimental group II on the score as measured by the post test in the case of Low Range Scorers for all the four second order personality factors. The mean values of the experimental group II were found to
be greater than that of the experimental group I for all the four second order personality factors. It is also found that there is significant difference between the means of the experimental group I and the experimental group III on the scores as measured by the post test in the case of low range scorers for all the four second order factors except for "Extroversion". The mean values of the experimental group III were found to be greater than that of the experimental group I for all the four second order factors. However, at the same time, it is also found that there is no significant difference between the means of the experimental group II and the experimental group III on the scores as measured by the post test in the case of Low Range Scorers.

Hence, it is concluded that the personality of the Low Range Scorers has an influence over the effectiveness of the Tutorial and Drill & Practice modes. The person who is shy, self-sufficient, troubled by pervasive emotionality, group dependent, chastened and passive personality differs in achieving the instructional objectives when he learns the subject through the different modes of CBI. Again it is found that the person who lacks motivation for difficult task, discouraged and passive personality is found to differ in achieving the instructional objectives when he learns through Simulation as one of the CBI modes.

It is found that there is significant difference at 0.01 level between the means of the experimental group I and the experimental group II on the scores as measured by the post test in the case of High Range Scorers for all the four second order personality factors. The mean values of the experimental group II are found to be greater than that of the experimental group I. It is also found that there is significant difference between the means of the experimental group I and the experimental group III on the scores as measured by the post test in the case of High Range Scorers for all the four second order
factors except for "Independence". The mean values of the experimental group III were found to be higher than the mean values of the experimental group I. At the same time, it is found that there is no significant difference between the means of the experimental group II and the experimental group III on the scores as measured by the post-test in the case of High Range Scorers for all the four second order personality factors.

It is concluded that there is difference between Tutorial and Drill & Practice modes of CAI in their effectiveness in realising the instructional objectives in Biology among those who are decisive, independent, daring and maladjusted. Again, there is difference between Tutorial and Simulation modes of CBI in their effectiveness in realising the instructional objectives among those who are decisive, socially outgoing, having high anxiety and resilient.

Hence, it is concluded that there is significant difference among the different modes of computer based instructions in realising the instructional objectives in the context of the learners' with varying levels of personality traits.

6. It is found that there is significant difference at 0.05 level between the means of the control group and the experimental group I on the scores as measured by the retention test at all levels of cognition except at application. The mean values of the control group were found to be greater than that of the experimental group I. It is also found that there is significant difference at 0.05 level between the means of the experimental groups II and III at all levels of cognition except at knowledge level. The mean values of the experimental groups II and III were found to be greater than the mean values of the control group.

Hence, it is concluded that there is significant difference between the Lecture Method and different modes of computer based instruction in terms of their effectiveness.
in enhancing the retention of what have already learnt. Lecture Method is less effective when compared to Drill & Practice and Simulation modes. However, at the same time, Lecture Method and Tutorial are almost equal in their effectiveness in this respect.

7. It is found that there is significant difference at 0.01 level between the means of the experimental group I and the experimental groups II and III on the scores as measured by the retention test at all levels of cognition. The mean values of the experimental groups II and III were found to be greater than that of the experimental group I. It is also found that there is significant difference between the means of the experimental group II and the experimental group III at all levels of cognition. The mean values of the experimental group II were found to be greater than that of the experimental group III.

Hence, it is concluded that there is significant difference among the different modes of computer based instruction in enhancing retention of what have already learnt. Among the different modes of computer based instruction, Drill & Practice is the most effective one, while Tutorial is the least effective one in enhancing the retention of what have already learnt. However, at the same time, Simulation stands between Tutorial and Drill & Practice in terms of its effectiveness in this respect.

**DISCUSSION**

Learning can be enhanced if the knowledge to be learnt were broken into small bits and each bit presented so clearly that the people could not make mistake. The immediate feedback at every correct response would have an effect on controlling behaviour. The sequential presentation of small pieces of knowledge into a logical sequence is called programme. It is called as programmed instruction. Programmed instruction is a game in which the learner can lose or win and learn more.
Personality and cognitive variables display individual difference. The sequential variables however involve random or logical sequencing of instructional information and this makes a demand for individuals action of learning.

Computers play a major role on learners and they provide direct interaction between the subject matter, teacher and the learner. Computers have a strong hold in the field of education (Bhatt, 1998). Several computer supported learning have been undertaken currently and they are found to have a positive outcome for enhancing learning (Barto, 1998; Chadwick, 1998; Din, 1994). The computer thus provides an alternative strategy to a teacher. Further it may also be perceived as a satisfactory and worthwhile alternative strategy to the teacher.

Computer takes a different role in instructional process. In instruction the role of the computer is mainly to provide direct instruction to the learners. CAI seems to be best in learning in the past and present. Altogether CAI is not only a sophisticated type of instruction but it is a different kind of instruction to learners. Learners' rate is faster with CAI than with conventional instruction. The retention of the learning using CAI is superior to retention following the traditional Lecture Method (Capper & Copple, 1985, Kulik, Bangest & Williams, 1983 and Kathleen Cotton, 1997).

The results of the study indicate that among the four instructional strategies viz. Lecture Method and CAI in Tutorial mode, Drill & Practice mode & Simulation mode, CAI in Drill & Practice mode is the most effective strategy in realising the instructional objectives in Biology at Higher Secondary level. CAI is more effective when compared to the lecture method. CAI in Drill & Practice mode is the most effective one in enhancing the achievement of the learners in Biology at all levels of cognition viz.
Knowledge, Understanding and Application. The same trend is found also in enhancing the retention of the learners in Biology. These findings support the existing studies stated earlier (Taylor, 1983, Sze, 1988, Din, 1994 and Crooks, 1996).

It is found that there is no personality influence in enhancing the achievement of the learners in Biology at all levels of cognition viz. Knowledge, Understanding and Application. It is evident from the studies conducted by (Elsberry Jeffrey brain, 1995, Rangaraj, 1995). Hence, the results of this study indicate that the enhancement of learning in Biology is only due to the media effectiveness. Therefore, it is evident that CAI can better be introduced in education at all levels for the successful realization of instructional objectives.

RECOMMENDATIONS

With a rapidly changing educational and technology scenario in the twenty first century, the role of the teacher and the teaching is fast changing, promoting fruitful learning and directing learners by adopting appropriate strategies. Technology provides a window to a future shift from print to electronic technology and towards a knowledge construction paradigm. Thus, the present study has several recommendations to those who are interested in keeping pace with the scientific innovations and those who do not want to lag behind in this technologically developing world.

1. From the findings of the study, it is was observed that CAI is more effective when compared to CLM in teaching Biology at Higher Secondary level. Hence, it is recommended that CAI strategy be used as an alternative strategy in regular classroom instructions in Biology.

2. It is observed that the CAI in Drill & Practice mode is more effective when compared to CAI in Tutorial and Simulation modes. Hence, it is recommended that the computer packages in Drill & Practice mode be used for teaching at higher level which may in turn increase students' cognition in curricular subjects.
3. As the application of the different CAI modes viz. Tutorial Drill & practice and Simulation is very effective one in the teaching – learning process, it is recommended that syllabus based computer software packages in Biology be developed more in number.

4. It is recommended that the instructional software packages may be developed with the computer managed testing for the reason that it enhances the teaching-learning process with proper feedback to the learners at appropriate time. Further, it is recommended to introduce computerised test administration for evaluation.

5. More software packages for the whole syllabus in different subjects be developed which may help the students to learn the subjects at their own pace. Further, while designing the computer packages, the psychological factors of the learners such as motivation, intelligence, etc be taken into account.

6. CAI materials be developed keeping the teacher in mind and how he appreciates the role he has to play in bringing the programmes to life.

7. The CAI packages in Biology be planned, developed, evaluated and implemented with the help of a team of experts comprising curriculum planners, educational technologists, computer experts and Biology teachers. It will be helpful in the development of quality packages for teaching and learning of Biology.

SUGGESTIONS FOR FURTHER RESEARCH

The present study has opened up many directions for future studies in the area of CAI, a few of which are given as follows:

1. The study may be replicated for various standards and for different content areas in Biology and other subjects to confirm the generalisability of the result and conclusions of the study.
2. The effectiveness of the application of different CAI modes in teaching to various disadvantaged groups, handicapped, the gifted and the like may be studied.

3. Researches may also be undertaken to study the effectiveness of various CAI modes viz. Problem solving, Instructional games etc.

4. Students' interest and willingness to study through the different CAI modes viz. Tutorial, Drill & Practice, Simulation and Instructional games and their effectiveness may also be studied in a longitudinal manner.

5. Researches may also be conducted to ascertain whether the use of multimedia would change further educational application of computers in Biology.

6. The realization of higher level instructional objectives in teaching and learning of Biology at Higher Secondary stage may also be studied in relation to different CAI modes.

7. The student's behaviour while learning through different modes of CAI may be studied with reference to the transcripts of the lessons transacted through the said media.