6.1. Summary

After a dedicated investigation for a period of two or more years, the investigator arrives at certain scientific conclusions. The worth of his investigations and the values of his findings largely depend on how the investigator summarises his research in a systematic way for others to understand and to follow or apply, if necessary. This chapter serves as a platform for this purpose for the researcher. This chapter highlights the rationale for selecting this problem, enumerates the objectives and the related hypotheses, specifies the need and importance of the study. Also, this chapter recapitulates the process applied and the products obtained. Yes, this chapter outlines the methodology adopted and lists out the findings arrived at. In addition, this chapter lays out the possible constructive suggestions for further research. Further, this chapter amplifies the implications of the study besides indicating the limitations of the study.
6.1.1. Introduction

National development of any country is decisively determined by the degree of human resource development achieved in that country. Effective utilization of all other resources available in a country also largely depends on the extent of human resource development attained. But human resource development is more easily said than done. It is a Herculean task with problems and challenges in every stage. Human resource development is an organised learning experience aimed at matching the organisational need for human resource with the individual need for career growth and development. It is a system in which a series of learning activities are designed to produce behavioural changes in human beings in such a way that they acquire desired level of competence for present and future role.

Human resource development is a planned and systematic approach to the development of people. It is not a fragmental or piecemeal approach but a total system of interacting elements designed to improve the total personality. Human resource development is a continuous process of developing the competencies, motivation, dynamism and efficiency of employees. It is based on the belief that there is no end to the development of an individual and learning is continuous throughout life.

Education is an effective means of accelerating human resource development. That is why Swami Vivekananda emphasised, ‘Educate our people, so that they may be able to solve their problems. Until that is done, all the ideals, reforms will remain ideals only. He further proclaimed, “Set yourselves to the task of spreading education among the masses. Kindle their knowledge with the help of modern science”.

This modern world of ours is certainly different from the ancient world or the middle ages. This breakthrough is largely due to science and its advancements. Now, one cannot simply think of the world without science. The present modern society entirely depends on scientific
achievements. Hence this is aptly called scientific age. So science education is of primary importance these days.

Science education plays a vital role in human resource development and national development. The growth of science and technology decisively determines the economic growth of a country. Without adequate development in the field of science and technology, a country cannot become a developed country. Hence science education is the kingpin of national development. Physics is a crucial subject of science which plays a vital role in national development.

Besides vast potential for diversification into various fields, physics offers wide scope in higher studies and research. A crucial subject among the sciences, physics has evolved over the years stretching its applications to numerous areas. To keep pace with the evolving science, higher education institutions seek to keep themselves abreast of the latest developments. Nonetheless, experts underscore the need to inculcate a scientific temper in students at an early stage to kindle the spirit of research.

Physics, according to French researcher Nicole Ostrowsky, is alive and constantly changing. “You need physics for a wide spectrum. The research of human genome cannot do without physics. The subject plays a huge part cutting across disciplines. “Physics is a crucial subject when compared to other sciences. It is essential to understand the world around us, world inside us and world beyond us. The subject has plenty of scope in higher studies and research. To teach such a crucial subject a teacher cannot rely on chalk and talk alone.

In the words of Swami Vivekananda, “the only true teacher is he who can immediately come down to the level of the students, and transfer his soul to the student’s soul and see through the student’s eye and hear through his ears and understand through his mind”. Such a teacher can really teach.

A real teacher should to be resourceful. Then only he can come down to the level of the learners in his classroom. In the era of science
and technology, a teacher cannot be successful without developing an indepth insight into the appropriate as well as advanced educational technology and instructional technology. An appropriate technology in the hands of a competent teacher can go a long way in achieving the predetermined educational objectives. This is where the computer assisted instruction exactly fits in.

The CAI software help to overcome barriers. They go beyond the four walls of the classroom. It fulfills the gap in learning. Different processes can be shown with ease. Inaccessible places can be viewed by sitting in the cozy classroom. These CAI software can penetrate deeply into human character with an immediate excitement than any other medium. The dual effect of audio and video strengthens and enriches the understanding and expedites the mastery of the concept.

CAI software are self-contained and auto-instructional material dealing with a single conceptual unit. It caters to the individual differences. Each student can take his own time to complete the CAI software. Here what matters much is the mastery of the subject, not the time. So these CAI software are very suitable to the various categories of students. Moreover, when we use drill and practice CAI software they are more effective, especially to under achievers low achievers etc. Stella (1993) developed a CAI software programme for teaching under achievers and found it quite effective. Likewise Ramar (1996) used CAI softwares to teach the slow learners and he found it effective in teaching English. Reddy and Ramar (1997) studied “the effectiveness of computer assisted instruction in teaching maths to slow learners” and they found that the strategy enabled the slow learners to reach the level of mastery learning.

Interactive CAI programmes were found to be more effective in comparison to linear video programmes (Abrams, 1986), and interactive CAI presentation took significantly less time than the lecture based presentation (Clark, 1987). Finally “CAI instruction material was found to be effective in terms of achievement and attitude of students towards ‘advance organiser model’ (James, 1988). From these it can be said that
computer assisted instruction is likely to be more effective in comparison to traditional method. But this is still a hypothesis because not many studies have been conducted covering subjects at different levels in Indian contexts.

Kumarasamy (2008), Kannan (2009) and Latha (2009) have established the effectiveness of CAI at higher secondary level in teaching various subjects. But no study has been attempted so far to verify the relative effectiveness of CAI with reference to various categories of students in the general education classroom. Hence an earnest attempt has been made in this investigation to apply drill and practice CAI and tutorial CAI in teaching physics to the plus one students and to assess the efficacy of the applied strategies with reference to various categories of students.

In the era of expanding knowledge, students can no longer remain passive dependents on teacher for knowledge. Student’s need is to learn to think independently and to adopt a fluid approach to learning. Growth in confidence, self direction, knowledge, skills, initiative, tenacity and motivation have been the characteristics of a typical learner” and De Rose (1968) recommends that they should learn how to go about learning because “teaching is not talking and learning is not listening” (Davis, 1976). There is something more, what is it? To find an answer, varied attempts have been made and one such is the present investigation in science education.

6.1.2. Title of the Problem

“RELATIVE EFFECTIVENESS OF TUTORIAL AND DRILL CUM PRACTICE COMPUTER ASSISTED INSTRUCTIONAL PROGRAMMES ON THE ACADEMIC ACHIEVEMENT OF VARIOUS CATEGORIES OF STUDENTS IN PHYSICS AT PLUS ONE LEVEL”

61.3. Objectives of the Study

General Objectives

1) To develop the CAI programmes to teach physics at plus one level.
2) To identify the high achievers, average achievers, under achievers and low achievers in the general education classroom.

3) To verify the effectiveness of CAI programmes on the achievement of high achievers, average achievers, under achievers and low achievers in physics at plus one level.

4) To establish the relative effectiveness of computer assisted instruction programmes with reference to various categories of students such as high achievers, average achievers, under achievers and low achievers.

5) To verify the advantage of the computer assisted instruction strategy over the traditional lecture method.

**Specific Objectives:**

1) To assess whether there is any significant difference in the pre-test performance of the students among the control group taught through traditional lecture method, experimental group I taught through drill and practice CAI programme and experimental group II taught through tutorial CAI programme in both rural and urban schools.

2) To know whether there exists any significant difference in the pre-test performance between the control group students and the students of experimental group I in respect of each category i.e. high achievers, average achievers, under achievers and low achievers in both rural and urban schools.

3) To measure whether there is any significant difference in the pre-test performance between the control group students and the students of experimental group II in respect of each category i.e. high achievers, average achievers, under achievers and low achievers in both rural and urban schools.

4) To assess whether there is any significant difference in the pre-test performance between the students of experimental group – I and experimental group II in respect of each category i.e. high achievers, average achievers, under achievers and low achievers in both rural and urban schools.

5) To find out whether there is any significant difference in the pre-test performance between the rural students and the urban students in
terms of group as a whole and in respect of each category i.e. high achievers, average achievers, under achievers and low achievers with regard to control groups, experimental group I and experimental group II.

6) To verify whether there is any significant difference in the pre-test performance among the various categories of students in the control group taught through traditional lecture method in both rural and urban schools.

7) To establish whether there is any significant difference in the pre-test performance among the various categories of students in the experimental group I taught through drill and practice CAI in both rural and urban schools.

8) To ascertain whether there is any significant difference in the pre-test performance among the various categories of students in the experimental group II taught through tutorial CAI in both rural and urban schools.

9) To assess whether there is any significant difference in the pre-test performance between the boys and the girls in the control group, experimental group I and experimental group II in both rural and urban schools.

10) To know whether there is any significant difference in the post-test performance of the students among the control group taught through traditional lecture method, experimental group I taught through drill and practice CAI programme and experimental group II taught through tutorial CAI programme in both rural and urban schools.

11) To measure whether there exists any significant difference in the post-test performance between the control group students and the students of experimental group I in respect of each category i.e. high achievers, average achievers, under achievers and low achievers in both rural and urban schools.
12) To find out whether there is any significant difference in the post-test performance between the control group students and the students of experimental group II in respect of each category i.e. high achievers, average achievers, under achievers and low achievers in both rural and urban schools.

13) To assess whether there is any significant difference in the post-test performance between the students of experimental group I and experimental group II in respect of each category i.e. high achievers, average achievers, under achievers and low achievers in both rural and urban schools.

14) To verify whether there is any significant difference in the post-test performance between the rural students and the urban students in terms of group as a whole and in respect of each category i.e. high achievers average achievers, under achievers and low achievers with regard to control group, experimental group I and experimental group II.

15) To establish whether there is any significant difference in the post-test performance among the various categories of students in the control group taught through traditional lecture method in both rural and urban schools.

16) To ascertain whether there is any significant difference in the post-test performance among the various categories of students in the experimental group I taught through drill and practice CAI in both rural and urban schools.

17) To assess whether there is any significant difference in the pre-test performance among the various categories of students in the experimental group II taught through tutorial CAI in both rural and urban schools.

18) To know whether there is any significant difference in the post-test performance between the boys and the girls in the control group, experimental group I and experimental group II in both rural and urban schools.
19) To measure whether there is any significant difference between the pre-test and the post-test performances in respect of the control group taught through traditional lecture method, experimental group I with drill and practice CAI programme and experimental group II with tutorial CAI programme in both rural and urban schools.

20) To find out whether there is any significant difference between the pre-test and the post-test performances in respect of each category of students i.e. high achievers, average achievers, under achievers and low achievers in all the groups in both rural and urban schools.

21) To verify whether there exists any significant difference in the retention test performance of the students among the control group, experimental group I with drill and practice CAI programme and experimental group II with tutorial CAI programme in both rural and urban schools.

22) To establish whether there is any significant difference in the retention test performance between the rural students and the urban students in terms of group as a whole and in respect of each category i.e. high achievers, average achievers, under achievers, and low achievers with regard to control group, experimental group I and experimental group II.

23) To ascertain whether there is any significant difference in the retention test performance between the boys and the girls in the control group, experimental group I and experimental group II in both rural and urban schools.

24) To assess whether there is any significant difference in the performance of the students of all the groups between the post-test and the retention test.

25) To know whether there exists any significant difference in the performance of all the categories of students in all the groups between the post-test and the retention test.
6.1.4. Assumptions of the Study

1) It is possible to develop CAI programmes to teach physics at plus one level.

2) There are ways and means to identify the high achievers, average achievers, under achievers and low achievers in the general education classroom.

3) The developed CAI programmes will enhance the achievement of the high achievers, average achievers, under achievers and low achievers in physics at plus one level.

4) The CAI programmes will be effective to high achievers, average achievers, under achievers and low achievers but the degree of effectiveness may vary from category to category.

5) The CAI strategy will have distinct advantage over the traditional lecture method.

6.1.5. Hypotheses of the Study

1) There is no significant difference in the pre-test performance of the students among the control group taught through traditional lecture method, experimental group I taught through drill and practice CAI programme and experimental group II taught through tutorial CAI programme in both rural and urban schools.

2) There exists no significant difference in the pre-test performance between the control group students and the students of experimental group I in respect of each category i.e. high achievers, average achievers, under achievers and low achievers in both rural and urban schools.

3) There is no significant difference in the pre-test performance between the control group students and the students of experimental group II in respect of each category i.e. high achievers, average achievers, under achievers and low achievers in both rural and urban schools.

4) There is no significant difference in the pre-test performance between the students of experimental group I and experimental group II in
respect of each category i.e. high achievers, average achievers, under achievers and low achievers in both rural and urban schools.

5) There is significant difference in the pre-test performance between the rural students and the urban students in terms of group as a whole and in respect of each category i.e. high achievers, average achievers, under achievers and low achievers with regard to control group, experimental group I and experimental group II.

6) There is significant difference in the pre-test performance among the various categories of students in the control group taught through traditional lecture method in both rural and urban schools.

7) There is significant difference in the pre-test performance among the various categories of students in the experimental group I taught through drill and practice CAI in both rural and urban schools.

8) There is significant difference in the pre-test performance among the various categories of students in the experimental group II taught through tutorial CAI in both rural and urban schools.

9) There is significant difference in the pre-test performance between the boys and the girls in the control group, experimental group I and experimental group II in both rural and urban schools.

10) There is significant difference in the post-test performance of the students among the control group taught through traditional lecture method, experimental group I taught through drill and practice CAI programme and experimental group II taught through tutorial CAI programme in both rural and urban schools.

11) There exists significant difference in the post-test performance between the control group students and the students of experimental group I in respect of each category i.e. high achievers, average achievers, under achievers and low achievers in both rural and urban schools.

12) There is significant difference in the post-test performance between the control group students and the students of experimental group II in
respect of each category i.e. high achievers, average achievers, under achievers and low achievers in both rural and urban schools.

13) There is no significant difference in the post-test performance between the students of experimental group I and experimental group II in respect of each category i.e. high achievers, average achievers, under achievers, low achievers in both rural and urban schools.

14) There is no significant difference in the post-test performance between the rural students and the urban students in terms of group as a whole and in respect of each category i.e. high achievers, average achievers, under achievers and low achievers with regard to control group, experimental group I and experimental group II.

15) There is significant difference in the post-test performance among the various categories of students in the control group taught through traditional lecture method in both rural and urban schools.

16) There is significant difference in the post-test performance among the various categories of students in the experimental group I taught through drill and practice CAI in both rural and urban schools.

17) There is significant difference in the post-test performance among the various categories of students in the experimental group II taught through tutorial CAI in both rural and urban schools.

18) There is no significant difference in the post-test performance between the boys and the girls in the control group, experimental group I and experimental group II in both rural and urban schools.

19) There is significant difference between the pre-test and post-test performances in respect of the control group taught through traditional lecture method, experimental group I with drill and practice CAI programme and experimental group II with tutorial CAI programme in both rural and urban schools.

20) There is significant difference between the pre-test and post-test performances in respect of each category of students i.e. high
achievers, average achievers, under achievers and low achievers in all the groups in both rural and urban schools.

21) There exists no significant difference in the retention test performance of the students among the control group, experimental group I with drill and practice CAI programme and experimental group II with tutorial CAI programme in both rural and urban schools.

22) There is significant difference in the retention test performance between the rural students and the urban students in terms of group as a whole and in respect of each category i.e. high achievers, average achievers, under achievers, and low achievers with regard to control group, experimental group I and experimental group II.

23) There is no significant difference in the retention test performance between the boys and the girls in the control group, experimental group I and experimental group II in both rural and urban schools.

24) There is no significant difference in the performance of the students of all the groups between the post-test and the retention test.

25) There exists no significant difference in the performance of all the categories of students in all the groups between the post-test and the retention test.

6.1.6. Scope of the Study

This experimental study encompasses the plus one students who toil and moil day and night for a better prospect in the academic career in the years to come. Instructional strategy is of vital importance for these students for mastery learning. Within a short period of one year, they have to make mastery learning of four vital voluminous subjects, which will decisively, determine the prospect of their future. Success of any instructional strategy lies in reaching out to the learners. To accomplish this task with a considerable degree of success, traditional lecture method alone cannot be relied on.
Of course, the traditional lecture method has its own merits for perfection in learning and for precise mastery learning, but the good old traditional lecture method need to be supplemented as well as complemented with certain innovative approaches, which can promote better mastery learning. Perfection in learning and precise mastery learning are the prerequisites for a performance par excellence in physics examination. There are various instructional strategies that can be of much use in achieving this objective.

An effective instructional strategy should cater to pupil diversities and it should reach out to all learners. The existing mode of instruction i.e., the traditional lecture does not rise to the occasion. It does not cater to individual differences and pupil diversities to a great extent. Also, the current trend is learner centred mode of instruction. With these views in mind, two modes of computer assisted instruction are earmarked for the study to verify the effectiveness of these modes with reference to different categories of pupils in an inclusive setting.

These modes cater to pupil diversities i.e. low achievers, under achievers and normal students. Low achievers in the rural area include mostly socially disadvantaged students, culturally affected, socio-economically backward, slow learners, students with mild learning disability and students with manageable handicaps. The proposed modes of instruction can accommodate the above pupil diversities. Moreover, these proposed modes of instruction are mostly learner centred and they cater to auto instruction to a great extent. They ensure student participation in a better way and provide for overcoming barriers to learning.

Keeping this efficacy in mind, commercial software were procured from Bangalore covering the units selected for the study. These software along with the ones developed by the investigator were made available for experimental CAI group students for learning selected subject units.
Ninety students from South Street Hindu Nadar Higher Secondary School, Muhavur in Virudhunagar District, Tamilnadu, were selected for the study to represent the rural student population. They were classified into three matching groups. The first group was experimental group-I, which was taught through drill and practice CAI. The experimental group-II was taught through tutorial CAI. The last group was control group and it was taught through traditional lecture method. Similarly ninety students were selected and classified as above to represent urban student population.

6.1.7. Need and Importance of the Study

Need and Importance of the study can be analysed from the point of view of instructional strategy and from the learners’ point of view.

The Point of View of Instructional Strategy

Teaching effectively is the most important of all the competencies required of a successful teacher. Since effective teaching deals with the needs, interest and abilities of pupils as individuals, it requires knowledge of the environment in which the pupil lives, the development problem he or she faces and his/her mental abilities. It is more true so when the teacher is dealing with the under achievers and low achievers. It also calls for an understanding of the learning processes essential for creating an environment where learning can take place and for making instruction so stimulating that every pupil will be motivated to learn. Stimulating pupils to think critically, independently and creatively is essential for effective teaching.

Effective teaching in any subject depends largely upon the introduction of new methods of instruction. There is a growing need for trying out newer methods of instruction and establishing their effectiveness in teaching. Now-a-days a teacher cannot depend on any single method of teaching. The teacher has to try out several innovative methods. The students are able to understand the concept, principles and content in an
effective manner when the innovative newer methods are incorporated in the teaching learning process.

The immense knowledge explosion taking place in the world warrants newer methods of teaching. Students need unique experience, which is provided in the modes of instruction selected for the study.

Destiny of a nation is being shaped in her classrooms. The growing number of under achievers and low achievers at all levels of our educational system warrants such a study, as this proposed one, to be undertaken for the enrichment of our teaching learning process.

Science is an important subject in the school curriculum that has two major problem areas that cause ineffective learning.

The Limitations of the Teacher: Most science teachers have in-depth knowledge only in their chosen elective such as Physics, Chemistry or Biology that is required to teach fundamental concepts in the discipline, but they are hampered in teaching other branches which they must teach anyway. Many teachers are not adept at using quick sketches to explain certain content, or in drawing diagrams in Biology. Some do not possess a big enough knowledge-base to link scientific content with day-to-day examples. For effective teaching of Science, teachers need to collect sample background information, for which they may not have the resources, time, or inclination.

Lack of Audio-visual Aids: Teachers often need to carry several charts, equipment, specimens, etc., even for teaching a single topic effectively. However, often these materials are either unavailable or inaccessible. Moreover, teachers do not have enough time between classes to procure and test it for its usability. Hence, most science classes are limited to uninspiring, and sometimes, incomprehensible verbal lectures.

It is believed that computers can not only help overcome these problems, but the vastly greater potential of this technology as an effective teaching aid, will cause a quantum leap in the quality of science teaching and learning.
However, in the past, new technology in teaching learning has not always proved effective. Most science teaching material available for use by teachers was not able to accommodate the individual needs of the teacher. For example, educational films produced abroad did not match the local curriculum and were hard to understand due to different accents.

Today, general-purpose, easy-to-use software such as Microsoft PowerPoint has become available. For the first time teachers can easily modify and even produce their own CAI material based on the needs of their own classes.

We therefore need to study afresh the utility of the current generation of hardware and software in teaching learning, and conduct research on what techniques are effective. This research is an earnest attempt in this regard.

**Learners’ Point of View**

Above all, human resource development should be at the focus of any research effort for a developing country like India which has abundant human resources. In the Indian system of education, it is observed that the human resources – teachers and learners, are under developed and perform less than their capabilities. The learners are under developed in the sense that they are not achieving in tune with their capabilities. Even some of the most efficient teachers are not adequately equipped to identify and guide the under achievers and low achievers to reach their optimum levels. As a result, the institutions, in turn, are not able to send their products into the society as fully developed learners. To ensure this we need a different strategy which can cater to individual differences. Computer assisted instruction is a new strategy which can be applied to various categories of students.

Although much has been achieved in this field of education, there are many opportunities for experiment and research. Throughout we have been constantly aware of the need for further investigation of the learning,
thinking and adjustment of slow learning children so that teaching method
can be precisely planned to suit their needs (Tansley and Gulliford, 1962).

Now the current trend is propagating auto learning by the learner
himself at his own pace. This paved the way for CAI, CAL, etc., Here, the
teacher is merely a facilitator of learning. He need not suffocate the
learners with all the information at a time. In auto learning, the learner can
take his own time and he can proceed at his own pace till he completes the
lesson. It is not the time but mastery learning which is the governing
criterion here. This is where the proposed CAI programmes exactly fit in.

Besides, cognition and conceptualisation depend on a chain of
events which begin with the learner’s perception of stimulus, be the
auditory, visual, tactile and olfactory. It is important that these initial
learning experiences be accurate, dependable and understandable. Unless
the learners’ initial sensory impressions are accurate, it will be impossible
for them to have reliable conceptualisation and understanding. With the
existing numerous kinds of aids, carefully organised presentation of
information through a variety of media should occupy the learner’s
conscious attention to living stimuli. This is what is precisely ensured by
the CAI programmes.

Students seem intrigued when they discover that the material they
normally can only find in a book or class lectures is also available to them
in a computer programme they can quickly master. The possibility of going
through the programme in a non-linear fashion, jumping ahead or
repeating sections at their will, gives the students a feeling of
empowerment and control over their learning progress. Being able to type
in their own answers (in the electronic notebook for short-answer
questions) makes the programme interactive and lively. Further, CAI has a
variety of inherently motivational features, such as visual effects, hidden
pop-up windows, linkages to other material, etc.

Perhaps the strongest motivational feature is a content one: the
questions in the CAI programme are similar to the ones the students will
encounter in daily quizzes, the mid term, and the final exam. There is a “data bank” of exhaustive alternate exam questions built up over the various offerings of the course, and most of these questions have been included in the CAI programme. By going through the complete programme, a student can feel that s/he is ready to face the similar questions in the exams. If a problem is encountered, the computer will provide a pop-up help screen, often containing explanatory information and a page reference to the textbook.

Computer Assisted Instruction has come in to stay for ever to wield greater influence in the teaching learning process. There is very urgent need to experiment the efficacy of computer assisted instruction and to assess its advantage over the traditional lecture method. No doubt, computer assisted instruction has a motivating quality of its own.


Though the efficacy of the CAI programmes has been established with reference to some category or other, the relative effectiveness of these programmes with reference to various categories of pupils in an inclusive setting is yet to be tried and tested. As catering to pupil diversity as well as reaching out to all learners is the vital principle of inclusive education, a beginning in this regard is to be made immediately on top priority basis.

Systematic researches, are therefore, necessary to assess the efficacy of CAI programmes so that educational technology can be brought into actual inclusive classroom practice. The present study is an attempt to assess the efficacy of computer assisted instruction in teaching physics at plus one level, and also to measure the relative effectiveness of various CAI programmes in inclusive classroom and their advantage over the traditional lecture method.

6.1.8. Methodology
The procedures followed in the study were development / procurement of drill and practice CAI software and tutorial CAI software for the physics subject of XI Standard, construction of research tool, sampling techniques design of the study, administration of tools for pre-test and post-test and statistical techniques that are employed for analysing the data.

6.1.8.1. Developing / Procuring CAI Software

Commercially available CAI software were procured from the International Educational Research Centre, New Delhi as well as from Bangalore. Apart from these software, the investigator took an earnest effort to develop computer software for CAI so as to suit the level of low achievers and below average students. A computer expert was consulted for the purpose and it was discussed with him how to develop software for CAI for the plus one physics. Though there are various CAI programmes the investigator decided to follow the first two i.e., drill and practice programme and tutorial programme since they are the most widely used types of computer programmes (Slavin, 1986). The purpose of this programme was to provide practice on skills and knowledge so that students can remember and use what they have been taught.

1. Letting students work at their own pace.
2. Providing immediate feedback and reinforcement
3. Measuring performance quickly and giving students information on their performance.

The software had to be developed in Tamil language since it was meant for Tamil medium students. Once the programming was over, it was subjected to tryouts. In the tryouts the students expressed that it was more conducive for learning at their own pace. Also, they found it more effective since the interaction with the computer had a motivating quality of its own. After this, the software for CAI programme was made ready for the use of the experimental group students.

6.1.8.2. Construction of Research Tool

To measure the performance of the students before and after the experiment, an achievement test was constructed by the investigator on
the basis of item analysis. Out of 120 objective type items, 100 items were finally selected on the basis of item analysis for the final form of the achievement test. The D values and the P values arrived at in the item analysis are given in Appendix – I. With regard to item difficulty, the percentage clustered around the 50 percent level in most cases. On the basis of this analysis, too easy and too difficult test items were deleted in the final form of achievement test. As for test item discriminating power, 50 percent of the test items had D-value exceeding +0.40, less than 40 percent had D values between +0.40 and +0.20, Also about 10 percent had D values between +0.20 and 0.0 and such test items were excluded from the final form of achievement test. The final form of achievement test is given in Appendix – II. The detailed procedures adopted to develop the achievement test and its validity and reliability are given in chapter – IV.

Each item was scored ‘one’ mark for the correct response and ‘zero’ for the wrong response. The duration of the test was 2 hours. The same achievement test was used as pre-test post-test and retention test for all the groups mentioned in the study. The English version of the final form of achievement test is given in Appendix – III.

6.1.8.3. Sample of the Study

For the purpose of this investigation, 90 students were selected from S.S. Hindu Nadar Higher Secondary School, Muhavur. All the students were taken form the plus one classes of the higher secondary course. The selected students had Physics as one of their subjects in the prescribed syllabus. All the students selected were from rural areas belonging to middle and low - income group. The selected students were equally divided into three groups to form two experimental groups required for the study and the control group. Similarly, ninety students from AAR Memorial Hr. Sec. School, Rajapalayam were selected and divided into three groups to represent urban student population.
**Procedure for Equating the Groups**

The sample of 90 students was divided into three groups of 30 students each. The three groups were equated as nearly as possible in terms of their achievement scores in the half yearly examination. Students having the same range of marks in the half yearly examination were equally and randomly allotted for experimental group and control group. To find out whether the control group and the experimental groups were matched ones or not, mean and standard deviation were calculated for the scores obtained in the half yearly examination by each group. Then t-test was applied to the scores of the control group and the experimental groups. The obtained t-values (0.43, 0.61, 0.51) were found to be not significant at 0.05 level. Hence, the three groups were matched ones in terms of their achievement before the inception of the experimental study. The same procedure was employed for urban groups also. The t-values obtained in respect of urban groups were also not significant at 0.05 level.

Also t-test was applied to the pre-test scores to verify, whether these groups were matched ones. The obtained F-values (0.07, 0.03, 0.28) were not significant at 0.01 level. Thus, all the F-values revealed that the three groups were matched ones before the inception of experimentation.

**6.1.8.4. Data Collection**

At the end of the experimental period, a post-test was conducted to the students of the experimental groups and the control group. Exactly 45 days after the post-test, a retention test was administered to all the groups to measure the degree of retention with regard to each mode of instruction. The responses given by the students in the pre-test, post-test and the retention test formed the vital data required for the analysis. The scores of all the groups in the pre-test, post-test and the retention test are given in Appendix –VI.

**6.1.8.5. Scoring Procedure**

The achievement test consisted of 100 objective type questions. The total score of test is 100. For each correct answer, the score is one and for each wrong answer the score is zero. The answer key to the achievement test in Tamil and English version is given in Appendix-V and VI.
6.1.8.6. Statistical Techniques Used in the Study

The data thus obtained were analysed using appropriate statistical techniques such as mean, standard deviation and t/F – test. In the first stage, mean and standard deviation (S D) of pre – test scores were calculated for all the three groups of students.

In the next stage, to know the effectiveness of the three modes of instruction in teaching Botany at plus one level, mean and S D were calculated for the post-test scores in respect of all the groups. Based on the mean and S D, t/F – test was calculated to know the significant difference, if any, among the groups or between any two groups. The same calculation was applied to retention test also.

6.1.9. Findings and Conclusions

1) There is no significant difference in the pre-test performance among the various groups selected for this study in both rural and urban schools. It indicates that all the groups i.e. control Group, drill and practice experimental group and the tutorial experimental group in both rural and urban schools are very much alike in the pre-test performance. All the three groups have shown a matching performance in the pre-test. Therefore, there is no variation in the pre-test performance between any two groups. Further, the obtained F-values show that all the three groups in rural or urban school were matched ones before the experimentation (refer table -1).

2) There is no significant difference in the pre-test performance between the control group students and the students of experimental group I in respect of each category i.e. high achievers, average achievers, under achievers and low achievers in both rural and urban school. All the corresponding categories of students in control group and experimental group I were very much alike in their pre-test performance and so there is no marked variation in their scholastic achievement before the experiment. All the t-values obtained in respect of rural school and urban school testify to the fact that all the
groups formed for this study presenting rural school and urban school were matched ones before experimentation. It can be observed that the finding of this table is in total agreement with the finding of Table – 1.

The table – 1 indicated that all the groups i.e. control group, experimental group I and experimental group II in both rural rural and urban schools were matched ones before the experiment at mean level. Table-2 shows that not only the groups but also the various categories of students i.e. high achievers, average achievers, under achievers and low achievers in control group and experimental group I in both rural and urban schools were matched ones before the applied experimental treatment. It establishes matching of the groups at micro level.

3) There is no significant difference in the pretest performance between the control group students and the students of experimental group II in respect of each category i.e. high achievers, average achievers, under achievers and low achievers in both rural and urban schools. There is no marked variation in their pre-test performance. It shows that students of the control group and the experimental group II in both rural and urban schools were matched ones not only at macro level as in table – 1 but also at micro level as in this table.

4) There is no significant difference in the pre-test performance between the students of experimental group I and experimental group II in respect of each of category i.e. high achievers, average achievers, under achievers and low achievers in both rural and urban schools. All the corresponding categories of students in experimental group I and experimental group II were very much alike in their pre-test performance and so there is no marked variation in their academic achievement before the experiment. All the t-values obtained in respect of rural school and urban school vouch for the matching of groups before experimentation. As table 2 and 3, this table also reveals that experimental group I and experimental group
Il in both rural and urban schools were matched ones even at micro level before the experimental treatment.

5) There is significant difference in the pre-test performance between the rural students and the urban students in terms of group as a whole and in respect of each category. The achievement of urban students in all the groups is better than the achievement of the rural students in the respective groups. At micro level also, the urban students of each category in each group are much ahead of their counterparts in respective category in rural groups. This table envisages the need for introduction of innovative strategy in the teaching learning process for the benefit of rural students.

6) There is significant difference in the pre-test performance among the various categories of students in both the rural control group and the urban control group. The high achievers in the rural control group and the urban control group are much ahead of the students of the other three categories in their group. They are followed by the average achievers and under achievers. The low achievers in the rural control group and the urban control group are in the lowest rung of the ladder. There is a clear cut hierarchical order in the order of merit. There is a wide gulf of difference between the high achievers and the students of other three categories. Similarly, there is a significant gulf of difference between the average achievers and the achievers of other two categories. This analysis indicates that the traditional lecture method, as an instructional strategy, could not enable the under achievers and the low achievers to cope with average students. It substantiates the need for a special strategy which can reach out to all the learners in the classroom.

7) There is significant difference in the pre-test performance among the various categories of students in the experimental group I in both the rural and urban schools. There is a distinct hierarchical order with high achievers at the apex and the low achievers at the bottom. There is a marked gap between any two categories. It discloses that
the instructional strategy of traditional lecture method does not hold good to reduce the gulf of difference found among the various categories of students in the classroom.

8) There is significant difference in the pretest performance among the various categories of students in the experimental group II in both rural and urban schools. The mean values indicate that the high achievers in both rural and urban experimental group II are very far ahead of the students belonging to the other three categories. There is a well marked difference between any two categories but the degree of difference varies from category to category. It also points out that the traditional lecture method also can not be relied upon to bring about optimum human resource development in the classroom. It envisages the need for application of educational technology in teaching learning process.

9) There is no significant difference in the pre-test performance between the boys and the girls in the control group, experimental group I and experimental group II in both rural and urban schools. Both the boys and the girls are very much alike in the pre-test performance. In some group the boys have better mean values, whereas in other groups the girls have better values. But the difference between the boys and the girls is not significant in any comparison. It asseverates that the traditional lecture method, as an instructional strategy, is effective to both the boys and the girls in same degree. This accounts for their matching performance in the pre-test.

10) There is significant difference in the post-test performance of the students in the control group taught through the traditional lecture method, experimental group I taught through drill and practice computer assisted instruction and experimental group –II taught through tutorial computer assisted instruction in both rural and urban schools. The achievement of the students in the experimental groups is better than the performance of the control group students
in the post-test. This applies to both rural and urban schools. Though the control group students and the students of both the experimental groups were very much alike in the pre-test performance, there is significant difference among them in the post-test performance. The significant difference between the control group and both the experimental groups is the outcome of the applied strategy. It accounts for the efficacy of drill and practice CAI and tutorial CAI. Further, there is no significant difference in the post-test performance between the experimental groups. It asserts that both the applied strategies i.e. drill and practice computer assisted instruction and tutorial computer assisted instruction are equally effective to both rural and urban schools. Also, this table brings to light the advantage of computer assisted instruction over the traditional lecture method.

11) There exists significant difference in the post-test performance between the control group students and the students of experimental group I in respect of each category i.e. high achievers, average achievers, under achievers and low achievers in both rural and urban schools. The students of all the categories in control group and experimental group I in both rural and urban schools were very much alike in the pre-test performance. But in the post-test performance there is a marked difference between the control group and the experimental group I in both rural and urban schools in respect of each category. The variation in the post-test performance can be ascribed to the efficacy of the drill and practice CAI applied during the period of experimentation. Further, this table establishes the advantage of drill and practice computer assisted instruction over the traditional lecture method.

12) There is significant difference in the post-test performance between the control group students and the students of experimental group II in respect of each category i.e. high achievers, average achievers, under achievers and low achievers in both rural and urban schools.
The students of all the categories in both rural experimental group II and urban experimental group II have surpassed their counterparts in the respective categories in academic excellence. Only the degree of excellence differs from category to category. Though the students of the control groups and the students of the respective experimental groups were very much like in the pre-test performance, there is a marked gulf of difference between them in the post-test performance. The variation in the post-test performance between the control group students and the students of experimental group II in both rural and urban schools can be attributed to the effectiveness of the applied strategy i.e. tutorial computer assisted instruction. Further, this table asseverates that the applied strategy i.e tutorial computer assisted instruction has been effective to various categories of students in the classroom. It substantiates that tutorial computer assisted instruction can be a viable strategy in inclusive setting as it can reach out to all the learners in the classroom.

13) There is no significant difference in the post-test performance between the students of experimental group I and the students experimental group II with regard to the categories such as high achievers, average achievers and under achievers in both rural and urban schools whereas there is significant difference in the post-test performance of low achievers between experimental group I and experimental group II in both rural and urban schools. The applied strategies of drill and practice computer assisted instruction and tutorial computer assisted instruction have been, by and large, very effective to the students belonging to the categories of high achievers, average achievers and under achievers. On the other hand, the drill and practice computer assisted instruction has been more effective to low achievers than the tutorial computer assisted instruction. This finding is in total agreement with the theoretical postulate of Reddy and Ramar who have stressed in their papers
that much drill, practice, review and revision are essential to enhance the achievement of low achievers.

14) There is significant difference in the post-test performance between the rural students and the urban students in terms of group as a whole. The urban students in all the groups i.e control group experimental group I and experimental group II are better than their counterparts in the respective rural groups. As for control group, the urban students are better than the rural students not only in terms of group as a whole but also in terms of each category. The difference between the high achievers in rural control group and the urban control group is significant at 0.5 level. But there is a wide gulf of difference between rural categories and the urban categories in respect of average achievers, under achievers and low achievers.

With regard to both the experimental groups, there is significant difference between the rural students and the urban students in terms of group as a whole. The achievement of both the urban experimental groups is better than the achievement of both the rural groups in the post-test. But the categorywise micro analysis brings to light that the high achievers in both the rural experimental groups have coped with their respective counterparts in the urban experimental groups. Though there was significant difference between the high achievers of both the rural experimental groups and both the urban experimental groups in the pre-test, there is no significant difference between them in the post-test. It shows that the rural bright students, when provided with right environment and innovative strategy, can cope with the urban students. Further, it substantiates that the applied strategies i.e. drill and practice computer assisted instruction and tutorial computer assisted instruction have been more effective to the category of high achievers in rural school.

With regard to the students of other three categories i.e. average achievers, under achievers and low achievers, there is
significant difference between the rural students and the urban students. The post-test performance of the students in the urban group is better than their counterparts in the respective categories in both the experimental groups. Though the average achievers under achievers and low achievers in both the rural experimental groups have made significant progress in the post-test, they could not match the category. The difference still persists even after the post-test. It vouches that the applied strategies i.e. drill and practice computer assisted instruction and tutorial computer assisted instruction have been equally effective to the students of aforesaid three categories in both rural and urban groups.

15) There is significant difference in the post-test performance among the various categories of students in the control group taught through traditional lecture method in both rural and urban schools. The traditional lecture method, as an instructional strategy, could not enable the students of any category to improve upon their pretest performance. Also, the traditional lecture method could not enable the under achievers and low achievers to cope with the students of other two categories. The same trend is prevalent in both the schools. It substantiates the need for application of innovative strategies in the instructional presentation.

16) There is significant difference in the post-test performance among the various categories of students in the experimental groups taught through drill and practice computer assisted instruction. The strategy has been effective to all the categories of students in both rural experimental group I and urban experimental group I. The experimental strategy enables all the categories of students to improve upon their pre-test performance. The progress made by each category of students can be attributed to the efficacy of the drill and practice computer assisted instruction. The strategy has been more affective to the rural under achievers and low achievers. It has enabled them to reduce the gap between them and the high
achievers to some extent. But this trend is not found among the students of urban experimental group I. This table asserts that drill and practice computer assisted instruction has been more effective to the students of all the rural categories than it is to the students of urban school.

17) There is significant difference in the post-test performance among the various categories of students in experimental group II taught through tutorial computer assisted instruction in both rural and urban schools. The strategy of tutorial computer assisted instruction has been effective to all the categories of students in both rural experimental group II and urban experimental group II. After the experimental treatment, the students of all the categories in both rural and urban schools have improved upon their pretest performance. The progress evinced by the students of each category in both rural and urban schools can be ascribed to the impact of tutorial computer assisted instruction applied during the period of experiment. It is much interesting of to note that the strategy has been more effective to rural under achievers and low achievers. It has enabled them to reduce the gap between them and the high achievers to some extent. But the strategy has been equally effective to the students of all the categories in experimental group II.

18) There is no significant difference in the post-test performance between the boys and the girls in the control group, experimental group I and experimental group II in both rural and urban schools. Both the boys and the girls are very much alike in the post-test performance. In some groups, the boys have better mean values whereas in some other groups the girls have better mean values. But the difference between the boys and the girls is not significant in respect of any category. It substantiates that the applied strategies i.e. drill and practice CAI and tutorial CAI have been equally effective to both the boys and the girls in same degree. This accounts for
their matching performance in the post-test after the experimental treatment. This finding is in total agreement with the findings of Kumarasamy, 2008, Kannan, 2008 and Latha, 2009.

19) There exists no significant difference between the pre-test and the post-test in respect of control group students in both rural and urban schools whereas there exists significant difference between the pre-test and the post-test in respect of both the experimental groups in rural and urban schools. The control group students could not make any progress in achievement in the post-test performance. So there is no significant difference in their performance between the pre-test and the post-test. On the other hand, the students of both the experimental groups in both rural and urban schools have shown remarkable progress in their post-test achievement. The students of both the rural experimental groups have shown a better performance than the students of both the urban experimental groups. So the level of significance is higher with regard to rural experimental groups.

The students of rural experimental group I have made a mean gain of 13.63 (73.73 – 60.10 = 13.63) whereas the students of rural experimental group II have shown a mean gain of 13.50 (95.53 – 60.03 = 13.50). In terms of rate progress, the rural experimental group and the rural experimental group II have registered 22.38% and 22.39% of rate of progress respectively. It implies that the drill cum practice computer assisted instruction and tutorial computer assisted instruction have been equally effective to the rural students.

The students of urban experimental group have registered a mean gain of (84.24 – 76.0 = 8.24) while the students of urban control group II have made a mean gain of 8.38 (85.31 – 76.93 = 8.38). In terms of rates of progress, the rate of progress shown by urban experimental group I amounts to 10.84 % whereas the rate of progress of experimental group II amounts to 10.97%. The significant difference between the control group and each of the
experimental groups in both rural and urban schools testifies to the advantage of drill and practice computer assisted instruction and tutorial computer assisted instruction over the traditional lecture method. The significant difference between the pre-test and the post-test in respect of all the experimental groups is the resultant product of the experimental treatment. The vertical progress made by the students of all the experimental groups in the post-test performance can be attributed to the effectiveness of the applied strategies i.e. drill and practice computer assisted instruction and tutorial computer assisted instruction.

20) There is no significant difference in the performance of the students of each category in rural and urban control groups between the pre-test and the post-test. There is significant difference in the achievement of the students of each category in each experimental group in both rural and urban schools between the pre-test and the post-test. In terms of relative effectiveness, the applied strategies have been more effective to the rural students than to the urban students. Micro analysis of this table brings to light that the under achievers and low achievers in rural experimental groups have benefited more than the students belonging to other categories. This table points out that the drill and practice computer assisted instruction and tutorial computer assisted instruction have successfully reached out to the students belonging to lower stratum. It bears testimony to the efficacy of the applied strategies in inclusive setting.

21) There is significant difference in the retention test performance among the students in control group, experimental group I and experimental group II in both rural and urban schools. The F-values simply point out that there is significant difference among the three groups selected for the study. But the F-values do not specify between which two groups there lies the significant difference. Hence to know between which two groups significant difference
exists, t-values have been calculated. The obtained t-values (control group Vs experimental group I – 2.87, control group Vs experimental group II 2.42) indicate that there is significant difference in the retention test performance between the control group and each of the experimental groups in both rural and urban schools. At the same time, there is no significant difference between the experimental groups either in rural school or in urban school. It establishes that both the applied strategies have been equally effective in terms of instruction as well as retention. This finding is in tune with the findings of Ramar, 1996, Thalaimalai, 2006; Kumarasamy, 2008; and Kannan, 2009.

22) There is significant difference in the retention test performance between the rural students and the urban students in terms of groups as a whole and in respect of categories such as average achievers, under achievers and low achievers. As for the control groups, the high achievers in both the control groups have shown a matching performance. With regard to other categories and groups as a whole, the performance of urban students is better than the performance of rural students. The same trend is seen in the retention test performance of the rural students and urban students in experimental group I. As for experimental group II, the high achievers and the low achievers have shown a matching performance in the retention test. So there is no marked difference in the retention test performance of high achievers and low achievers between the rural school and the urban school. With regard to other categories and groups as a whole there is significant difference and the achievement of urban students is higher than the achievement of rural students.

23) There is no significant difference in the retention test performance between the boys and the girls in the control group, experimental group I and experimental group II in both rural and urban schools. Both the boys and the girls are very much alike in the retention test
performance. In some groups the boys have better mean values whereas in some other groups the girls have better mean values. But the difference between the boys and the girls is not significant in respect of any category. It substantiates that the applied strategies i.e. drill and practice CAI and tutorial CAI have been equally effective to both the boys and the girls in same degree. This accounts for their matching performance in the retention test after the experimental treatment. This finding is in total agreement with the findings of Kumarasamy, 2008, Kannan, 2008 and Latha, 2009.

24) There is no significant difference in the performance of the students of both the control groups and both the experimental groups between the post-test and the retention test. It shows that the performances of all the groups are almost alike in the post-test as well as in the retention test. It is to be noted that the applied strategy has enabled the students of both the experimental groups to maintain the post-test progress in the retention test also, without any decline. It establishes the efficacy of the applied strategy in terms of ensuring retention. The applied strategy could facilitate the retention of the concept learned during the period of experimentation, even though the retention test was conducted 45 days after the post-test. This table vouches for the effectiveness of applied strategy not only in instruction but also in retention of the learned concept.

25) There exists no significant difference in the performance of the high achievers, average achievers and low achievers in all the groups between the post-test and the retention test whereas there is significant difference in the performance of the under achievers in all the groups between the post-test and the retention test. Their performance is better in the retention test than in the post-test. The low achievers in the control group have also improved upon their post-test performance. It indicates that review and revision have more impact on under achievers and low achievers than other students. Hence their performance is better in the retention test.

6.2. Implications of the Study
1) The results of the study have established that computer assisted instruction is more effective than the traditional lecture method in teaching the physics subject of standard XI to the low achievers. When it is very effective to the low achievers, it has to be equally effective, if not more effective, to the normal students also.

2) Teachers of Middle Schools and High Schools can be given orientation as to how to develop and how to apply CAI software especially drill and practice CAI for the use of low achievers, slow learners etc.

3) Keeping the result of the study in mind the NCERT and SCERT should take up the work of producing CAI CDs as they produce teachers Hand Book and different multi-media packages can be developed and supplied to the schools. If it is not possible to supply to all the Schools, a central library may be set up at district headquarters to lend the CAI packages to the aspiring schools. Since almost all the schools have T.V. /computer of their own, it will be very much possible for them to play the packages and the students can view the instructional programmes based on their subject units.

4) CD - ROMs can be developed based on the subject units by the NCERT, SCERT and even by commercial agencies and the schools can procure them either from science fund or from the audio visual fund in the special fees account.

5) Since the use of computer assisted instruction enhances the achievement of low achievers, it will diminish wastage and stagnation in our schools. So, a necessary orientation can be given at DIET level also so that awareness can be developed among primary school teachers also.

6.3. Delimitations of the Study

The limitations of the study are as follows:
1) The study is confined to the plus one students studying in South Street Hindu Nadar Higher Secondary School, Muhavur, Virudhunagar district of Tamil Nadu state.

2) The rural as well as urban sample consists of 90 students at the rate of 30 for each group.

3) Only three units in plus one physics syllabus have been included for this study.

4) The experiment was conducted for a period of 45 days at the rate of one hour per day.

5) For the computer assisted instruction, commercially available computer assisted instruction software and the CAI software developed by the researcher were used for the experiment. They were used in the physics laboratory where the experiment was actually carried out. The experimental CAI group students were not permitted to take them home to avoid the students in other groups using the said software which would distort the result.

6) As far as this study is concerned, various categories of students include the high achievers, the average achievers, the under achievers and the low achievers in the classroom of the investigator.

7) The achievement test used in the study is a teacher made one with its own validity and reliability.

6.4. Suggestions for Further Research

1) In this study, computer assisted instruction has been found very effective to teach physics subject of Standard XI to low achievers. To ensure more dependable conclusions, the experiments may be conducted on a wide range of schools.

2) A parallel study could be made to find out the effectiveness of computer assisted instruction at high school and at middle school levels.
3) A parallel study can be made to find out the effectiveness of computer assisted instruction with special reference to slow learners, learning disabled etc.

4) A parallel study can be made covering the full syllabus of a particular subject and internal analysis can be done.

5) A comparative study can be made in rural and urban areas selecting students from both the areas.

6) A study can be undertaken to assess the attitudes of the students and teachers of High and Middle Schools towards the computer assisted instruction.

7) A similar study can be carried out in teaching other subjects of plus one syllabus.

8) A survey can be undertaken to assess the availability of video equipments and training needs of humanities and science teachers for developing CAI software especially for the units of different subjects at middle school and high school levels.

9) A similar study can be undertaken to study and measure the effectiveness of computer assisted instruction with reference to various categories of students with special needs in inclusive setting.

10) Separate studies can be undertaken to assess the efficacy of other modes of computer assisted instruction i.e. generative computer assisted instruction, dialogue / enquiry computer assisted instruction and simulation programme computer assisted instruction.