METHODOLOGY
CHAPTER - III

METHODOLOGY

The basic thrust of this research work is to find out the effectiveness of Computer-Assisted-Instruction (CAI), compared to the conventional method of Teacher Instruction (TI) in the classroom, on the performance of primary school students in biology.

The independent variables selected for the study can be meaningfully grouped into three categories as follows:

1) Student-related variables
2) Computer-related variables and
3) Environment-related variables (A schematic representation of the variables within each group and the hierarchical relationship is given in Figure 1).

The measurement of these variables helps in assessing the performance of the students.
The student related variables selected for the study are: a) age b) sex c) students’ preferred mode of working with the computer d) the personality traits of the students as tested by the Cattell’s C.P.Q (14-P.F)

The Computer-related variables selected for the study are:

a) the students’ exposure to computer at home as well as places other than school.

b) the students’ knowledge about computers acquired through T.V., Books, Magazines, and Newspapers.

The Environment-related variables selected for the study are:

a) Socio-economic status of the students’ family (Per-capita income)

b) Fathers’ Occupational Category and
c) Mothers’ occupational status

**Objectives:**

**I Performance of students:**

1.1 To study the effectiveness of Computer-Assisted-Instruction (CAI) in biology compared to conventional method of Teacher Instruction (TI) in the classroom, on the performance of primary school students.

**II Student-related variables:**

2.1 To ascertain the association if any, between **age** and i) the performance score under CAI and ii) the score differential of the students between the two methods of instruction namely CAI and TI

2.2. To ascertain the association if any, between **sex** and i) the performance score under CAI and ii) the score differential of the students between the two methods of instruction namely CAI and TI

2.3. To ascertain the association if any, between students’ **preferred mode of working with the computer** (i.e. Individually, In pairs, and In groups) and i) the performance score under CAI and ii) the score differential of the students between the two methods of instruction namely, CAI and TI
2.4. To ascertain the association if any, between the traits of the personality of the students as tested by Cattells’ C.P.Q. (14 P.F) and the score differential of the students between the two methods of instruction namely, CAI and TI

**Computer-related variables:**

3.1 To ascertain the association if any, between the students' exposure to computer at home as well as places other than the school and i) the performance score under C.A.I, and ii) the score differential of the students between the two methods of instruction namely C.A.I and T.I.

3.2 To ascertain the association if any, between the students' knowledge about the computer acquired through educational programmes on T.V., Books, Magazines and Newspapers and i) the performance score under C.A.I and ii) the score differential of the students between the two methods of instruction namely C.A.I and T.I.

3.3 To ascertain the association if any, between the combined effect of both exposure to computer and knowledge about the computer acquired through media and i) the performance score under C.A.I and ii) the score differential of the students between the two methods of instruction namely C.A.I and T.I.

**Environment-related variables:**

4.1 To ascertain the association if any, between the socio-economic-status (per-capita income) of the students' family and i) the performance score under CAI and ii) score differential of the students' between the two methods of instruction namely, CAI and TI.
4.2 To ascertain the association if any, between fathers' occupational category, and i) the performance score under CAI and ii) the score differential of the students between the two methods of instruction namely, CAI and TI.

4.3 To ascertain the association if any, between mothers' occupational status (working / non- working), and i) the performance score under CAI and ii) the score differential of the students' between the two methods of instruction namely, CAI and TI.

Hypothoses:

In accordance with the above objectives the following null hypotheses were formulated:

I Performance of students:

1. There will be no significant difference in the performance score of students under the two methods of instruction (CAI and TI)

II Student-related variables:

2.1.1 There will be no significant difference in the performance score under CAI with reference to the Age of the students.

2.1.2. There will be no significant difference in the score differential of students between the two methods of instruction namely C.A.I and T.I. with reference to the Age of the students.

2.2.1 There will be no significant difference in the performance score under CAI with reference to the Sex of the students.
2.2.2 There will be no significant difference in the score differential of students between the two methods of instruction namely C.A.I and T.I. with reference to the Sex of the students.

2.3.1 There will be no significant difference in the performance score under CAI with reference to the students' preferred mode of working with the computer (i.e., Individually, In pairs and In groups).

2.3.2 There will be no significant difference in the score differential of students between the two methods of instruction namely C.A.I and T.I. with reference to the students' preferred mode of working with the computer (i.e., Individually, In pairs and In groups).

2.4 There will be no significant difference in the score differential of the students between the two methods of instruction (CAI and TI) with reference to the personality traits of the students as tested by Cattell's C.P.Q. (14-P.F).

m Computer-related variables:

3.1.1 There will be no significant difference in the performance score under CAI with reference to the students' exposure to computer at home and in places other than the school.

3.1.2 There will be no significant difference in the score differential of the students between the two methods of instruction (CAI and TI) with reference to the students' exposure to computer at home and in places other than the school.
3.2.1 There will be no significant difference in the performance score under CAI with reference to the students' knowledge about computers acquired through educational programmes on T.V., Books, Magazines and Newspapers.

3.2.2 There will be no significant difference in the score differential of the students between the two methods of instruction (CAI and TI) with reference to the students' knowledge about computers acquired through educational programmes on T.V., Books, Magazines and Newspapers.

3.3.1 There will be no significant difference in the performance score under CAI with reference to the combined effect of both exposure to computer and knowledge about computers acquired through media.

3.3.2 There will be no significant difference in the score differential of the students between the two methods of instruction (CAI and TI) with reference to the combined effect of both exposure to computer and knowledge about computers acquired through media.

rv Environment-related variables:

4.1.1 There will be no significant difference in the performance score under CAI with reference to the per-capita income of the students' family.

4.1.2 There will be no significant difference in the score differential of the students between the two methods of instructions (CAI and TI) with reference to the per-capita income of the students' family.
4.2.1 There will be no significant difference in the performance score under CAI with reference to fathers' occupational category.

4.2.2 There will be no significant difference in the score differential of the students between the two methods of instructions (CAI and TI) with reference to fathers' occupational category.

4.3.1 There will be no significant difference in the performance score under CAI with reference to mothers' occupational status (working/non-working).

4.3.2 There will be no significant difference in the score differential of the students between the two methods of instructions (CAI and TI) with reference to mothers' occupational status (working/non-working).

**Tools used:**

1) Commercially available Brand -I software
2) Commercially available Brand - II Software (The reason for going in for Brand II software is given later in this study)
3) Forms B1 and B2 of the Cattell's C.P.Q (14-P.F)
4) Investigator developed Cuestionnaire
5) Teacher made Paper-pencil objective test

**Development of the Tools:**

The questionnaire was designed to collect background information about the students.
The questionnaire consists of the following:

a) items eliciting identification data (which are not processed)

b) student related information namely age, sex, preferred mode of working with the computer

c) computer related information namely students' exposure to computer at home and places other than school, students' knowledge about the computer and sources of this knowledge

d) environment related information such as per capita income of the students' family, fathers' occupational category and mothers' occupational status

It can be readily seen that items under 2, 3 and 4 have been hypothesised to mediate the students' relative receptivity to CAI (A copy of the questionnaire is given in appendix).

Teacher made test: -

It was an objective type paper-pencil test. It consisted of multiple choice, true or false and fill up the blank items.

The study was conducted in two stages. Stage I comprised the experimental study and Stage II involved two strategies, i.e. 1) Tool based quantifiable data using Cattell's C.P.Q(14- P.F) and the investigator developed Questionnaire.

2) Qualitative, exploratory enquiry involving a face to face interaction between investigator and select students and a Focus group discussion among a panel of administrators, teachers and a few parent volunteers. The qualitative exploratory enquiry was undertaken impromptu because the trend of the findings based on the quantitative data...
was not in the direction originally expected at the outset of the study. The stages of the study can be diagrammatically represented as follows:

**STAGES OF THE STUDY**

- Selection of Schools
- Selection of teachers
- Selection of Samples
- Orientation Programmes and Pilot Study
  - Pilot Study I: Orientation and testing of Brand-1 Software
  - Pilot Study II: Orientation and testing of Brand-2 Software

**Final Study**
Two groups of students undergo two instructional methods (CAI and TI) for two chosen lessons in Biology introduced by Double-Group Rotational Design.

**Quantitative Analysis**
- Questionnaire to children
- Teachers made paper-pencil objective type test Scores computed
- CPQ (14-PF) to children

**Qualitative Study**
- Interactive sessions with Students selected based On highest/lowest score differentials between CAI and TI
- Focus Group Discussion with administrators, teachers and parents

Fig-2
Rationale for selecting the Double-Group-Rotational Design:

The Double-Group-Rotational design was selected because the study attempted to compare the relative effectiveness of two methods of instructions namely, CAI and TI. Rotational design were adopted because no ready made benchmark measures of all the students' level of performances was available; a number of pupils had joined the school in standard V from other schools. The comparability of the standard of these schools was a moot point and the marks of many of the outside students in the previous examination were not readily available, nor was it possible to conduct a suitable pre-test for all of them as it was the beginning of the academic year.

The advantage of the Double-Group-Rotational Design is that it does away with the necessity for equating the experimental groups; both the groups are exposed to both the methods; thus the initial differences in their levels of performance is eventually neutralised; and the comparison of performance are made method wise and not group wise.

Of the three factors to be borne in mind while choosing the experimental design, two (namely the purpose of the experiment and the field conditions) were relevant at this point of choosing the design. The third factor mentioned by Best (1989) (namely, the nature of the variables to the manipulated) governed the choice of the experimental site and the subjects.

Double-Group-Rotational Design can be presented as follows:

<table>
<thead>
<tr>
<th>Table - 3.1</th>
<th>Double Group Rotational Design</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group 1</td>
</tr>
<tr>
<td>Phase 1 (CAI)</td>
<td>L1</td>
</tr>
<tr>
<td>Phase II (TI)</td>
<td>L2</td>
</tr>
</tbody>
</table>

L - denotes Lesson
In Double-Group-Rotational Design Both the Groups are exposed to both the methods of instruction, with the order of presentation of the lesson and the method reversed. Thus the performance scores of both the groups for both the methods are separately obtained. By pooling the performance scores of all the students' method wise, a valid comparison of the relative effectiveness of the two methods of instruction can be made.

In this study, care has been taken to choose two lessons of equal difficulty level as adjudged by a panel of subject experts (five senior and experienced science teachers) based on specific criteria for ascertaining the difficulty level of the lessons (Infi-a: section on selection of lessons.). The problem of variations due to the differences in the difficulty level of the lessons confounding the variations due to the different methods of instruction has thus been reckoned with.

**Selection of the experimental site:**

Selection of the experimental site was determined by the field conditions namely,

1. The availability of multimedia computer laboratory for conducting the experiment.
2. The permission of the management of the institution to conduct the experiment and the co-operation of the teachers.
3. The schools should already be offering computer-education to the students at the primary level so that the students are familiar with rudimentary computer-operations.

**Selection of the sample:**

The sample comprised 210 students (116 boys and 94 girls) from Standard V from two schools in Chennai where computer-education programmes were a part of the school
curriculum from standard III, So at the time of the study students from both the schools had been exposed to computer operations for a period of two years.

From School I the total population from the standard V was selected (n = 168) because the institution was willing to permit all the students of standard V (n= 168) to be included in the study.

From School II every fifth student from the attendance register from each of the five sections was selected (n= 42). The sample from school II consisted a fifth of the total population of the students in standard V there.

Reasons for selecting the random sample from school II were as follows:

1. School II had computers of lower configuration for teaching computer programmes to students from standard III onward as part the school curriculum. But school II did not have a laboratory with multimedia computers indispensable for conducting the experiment and therefore it was decided to take the co-operation of school I and use their computer lab for this experiment.

2. It was not feasible to transport all the students physically from School II to School I where multimedia computers were available for conducting the experiment. Hence a sample (n=42) out of the available population from standard V in school II was picked. The selected 42 students from school II were taken to school I.

The students of school II who have already been exposed to Logo programs in their school were first given an orientation for learning from computers through CAI method.
using educational software in biology in the multimedia computer laboratory of school I.

**Selection of the Teachers:**

Four science teachers from school I and two science teachers from school II were chosen to teach the Standard V students of their own respective schools' two lessons in Biology by the conventional method in the classroom. The criteria followed by the investigator for selecting the teachers were:

1. All the science teachers selected for the experimental study be professionally trained, duly qualified graduate teachers.
2. All the science teachers selected for the experimental study have a minimum of three years of experience in teaching biology to standard V students.
3. All the teachers were oriented by the investigator to the experiment. Lesson instructions were standardised and the teachers were asked to use the black board and two teaching-aids (a model and a chart), for teaching the lessons selected for the study in order to maintain uniformity in the conventional class room method of instruction.
4. Teachers from school II were taken to school I along with the children from that school.

**Orientation of the Teachers:** The teachers were given an orientation by the investigator, towards ensuring uniformity of treatment under the T.I method.

Instructions (Ref. Box I) were given to the teachers who were selected to teach science lessons through the conventional method of teacher instruction (T.I):
Box - 1 Instructions to teachers

1. It is an experimental study to test the relative effectiveness of the two methods of instruction namely CAI and TI and not that of the teachers in either school
2. Time allotted for teaching each lesson is about 30 minutes.
3. Time allotted for the revision of the lesson through question and answers is about 10 minutes.
4. Each teacher should use the black-board in the classroom and two teaching-aids (a model and a chart)
5. The teacher-made, paper-pencil, objective type test should be given at the end of the question and answer session.
6. Students must not be informed during the teaching session, about the test to be followed.
7. Students should not be hurried to complete the test. They should be given sufficient time to complete it as it is a “power-test” and not a “speed-test”.

Field Constraints:

It was not possible to have the same teachers for teaching the selected lessons through T.I method to all the batches of students as the teachers had to follow the school schedule. Hence the investigator sought the assessment of the school management in this respect and matched the teachers on the above mentioned criteria and selected the teachers with the support of the school management for the present study. In the opinion of the principal, the academic supervisor of the all teachers, they were comparable in their level of teaching competency despite small differences in their length of experience. It was not possible to control either experimentally or statistically any inherent differences in the teachers' level of competencies. Experimental control would have involved getting the same teacher or teachers with the same level of qualification and experience to teach all the classes.
Controlling it statistically would have required generating measures about their comparative level of performance. Neither of these was feasible. So the investigator had to proceed on the postulate that the assessment of the principal about the comparability of the teachers is a valid and reliable observation. The investigator was aware at this point that, should the findings about the relative effectiveness of CAI Vs TI in the different classes taught by the different teachers be in different directions, the findings could not be confidently attributed the method of instruction per se, in as much as the equation of the level of competencies of all the teachers, has been made on the basis of the Principal's recommendations and the teachers' willingness to participate in this investigation.

Selection of the Software:

The investigator scanned the research journals for the criteria for selection of multimedia educational software for the experimental study. After going through the literature on courseware evaluation and analysis of a wide range of courseware evaluation Instruments, the investigator found that, the available courseware evaluations Instruments lacked uniformity in evaluation procedures. Hence the investigator used the Courseware Evaluation Form developed by Sivaraj Pandian (1998) which was a consolidation of evaluation procedures suggested by the following authors (Cobum et.al 1982; BuUough and Beaty 1987,89,Bleast1986, Fetter 1984).

The following criteria were delineated for courseware evaluation by Sivaraj Pandian (1998).

The Evaluatory criteria of courseware:

i. Content characteristics:
   a. The appropriateness of content
   b. Statement of Instructional objectives,
   c. Extensive use of examples and illustrations to clarify content, etc.
ii. **Instructional characteristics**: The methods, strategies, etc for delivering the content
   a. Logical presentation of the content
   b. Reckoning with the students’ previous learning experience
   c. Motivation
   d. Ability level of students,
   e. Self-pacing,
   f. Feedback etc.

iii. **Technical characteristics**: Some techniques used in enhancing the learning competencies of students as:
   a) Screen display of content
   b) Graphics / animation
   c) Music
   d) Manual and user-support materials, etc.

The above mentioned criteria given by Sivaraj Pandian (1998) were used as a basis for the selection of software used in the study. (The criterion pertaining to 'Management' in his model was omitted because it is not relevant in the context of the present study).

**The status of the Educational Software market at the time of the study:**

Lists of several sets of criteria for the selection of software were first surveyed and one set of criteria that has been developed under Indian conditions most recently was chosen. However when the investigator entered the market for picking and choosing software that would meet this set of criteria it was found that at that point in time one brand of multimedia software was available. It was thus a Hobson's choice: there was no other go but to choose the only available brand. Evaluating it in terms of any criterion was superfluous. Nevertheless, as an opportunity for evaluatory exercise the investigator sought to assess and internally rank the three domains of the criteria namely the content characteristics, instructional characteristics and technical characteristics. As per the
investigator’s assessment, which was also corroborated by the teachers involved in the experiment. The ranking of the three domains of the software were as follows:

<table>
<thead>
<tr>
<th>Domain</th>
<th>Rank</th>
</tr>
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<tbody>
<tr>
<td>Content Characteristics</td>
<td>1</td>
</tr>
<tr>
<td>Instructional Characteristics</td>
<td>2</td>
</tr>
<tr>
<td>Technical Characteristics</td>
<td>3</td>
</tr>
</tbody>
</table>

**Selection of the Lesson:**

The Investigator and a panel of five science teachers who participated in the experimental study used the following criteria for selecting the lessons:

1. The concepts used in the lesson correspond to the level of the Standard V syllabus of the Central Board of Secondary Education, because the software had not been prepared standard specific.

2. The Lessons selected for testing were of equal difficulty level as approved by the panel of five science teachers on the basis of the following characteristics.
   a) Number of concepts
   b) simplicity/complexity of concepts
   c) Time duration the module would take for teaching.

**Orientation Programme-1**

Investigator conducted an orientation programme for the students of School I and School II with the help of four teachers selected for the study and two Computer personnel in batches of 10 students each in the multimedia laboratory of school I. Initially the 60 sample subjects who would participate in the pilot study were given the orientation and subsequently, all the remaining students from Standard V in School I were made to attend this orientation programme. The chosen lesson for the orientation programme-1 was titled "Herbs, Shrubs and Trees". The orientation programme did not cover the contents of the
lesson but only included directions as to how to use the educational software for learning and to repeat learning.

**Box - 2 Instructions given to each batch of students using Brand-I Software:**

All of you are familiar with the method of learning from the teacher in the classroom or from the textbook. Now you are being introduced to a new method of learning called Computer-Assisted-learning or CAI for short. You are going to learn from the Educational Software a Biology lesson on your own. Each one of you look at the monitor of your Computer. You find a lesson titled "Herbs, Shrubs and trees on the screen. You can also observe that there is a pointer on the screen there are two arrows at the bottom of the screen, one pointing to the right (→) and one pointing to the left (←). There is also a mouse attached to your Computer. Move the mouse by dragging it on the mouse-pad in order to make the pointer on the screen coincide with the arrow pointing to the right Click the left mouse button on the right arrow which you find at the bottom of the screen. Now you find that you have moved to the next part of the lesson. Read through the text on the screen and observe the figures moving on the screen. Use your headphone to hear the voice recording of the lesson. This way you continue by clicking on the right arrow for proceeding with the lesson. If you want to go back to the earlier part of the lesson once more, click on the arrow pointing to the left at the bottom of the screen by dragging the mouse on the mouse-pad and clicking the left mouse button. This way you can go forward or backward with the lesson as you like. When you have finished learning the lesson once, ask for help so that one of the teachers will take you to the beginning of the lesson in the software once again so that, you can repeat the learning all over again. Please do not rush. You will be given sufficient time to learn the lesson twice or thrice as you like. If you have any difficulty in operating the computer, ask for help from one of us present here. Now you can start exploring the lesson from the educational software individually, on your own, at your own pace.

After the instructions were given, students started learning from the educational software on a one student to one computer basis on their own at their own pace. Investigator and the panel of two teachers and one Computer Laboratory in-charge helped the students in each
batch whenever they needed assistance. Students were given sufficient time to repeat the lesson. They were allowed to go back and forth with the lesson while learning from the Educational Software. They were encouraged to repeat the lesson twice or thrice. At the end of the learning session students were given a Teacher-made, paper-pencil, objective type test for 20 marks based on the lesson they had just learnt. Students were given adequate time to complete the test. This was done in order to ensure that they had the experience of writing a test after learning from C.A.I. method of learning so that they can do this with ease and confidence in the future learning and testing sessions on C.A.I.

Pilot Study-1:
A Pilot study was conducted in School I to ensure that the tools used and methods of data collection were feasible, to ascertain time limits and to ensure uniformity and standardization of procedures.

The Experimental method was used for the Pilot study. The Double-Group-Rotational Design was used where both groups were taught by both methods of instructions namely C.A.I. and T.I. by reversing the order of treatment between the two groups.

Selection of the lesson:
Two lessons in Science of equal difficulty level as adjudged by a panel of five science teachers were selected based on specific criteria as mentioned earlier. The teachers were requested to go through the Brand I educational software and the textbook prescribed by the Central Board of Secondary Education. Two lessons of equal difficulty level were chosen for the present study. The chosen lessons were:

\[\text{Lesson 1} \quad - \quad \text{Man and his environment}\]
\[\text{Lesson 1} \quad - \quad \text{Living and Non-living things}\]

Tools used for the study:
1. The Brand-I Multimedia Educational Software developed by a Chennai based Software Company was used for the pilot study.
2. An objective type paper-pencil test prepared by the Investigator in collaboration with a team of five science teachers from School I were used for testing the students' attainment in Lessons 1 and 2.

Method

The investigator selected two sections out of the four sections A, B, C and D from Standard V from School I based on their class average in Science in the previous year's final examination. Hence previous year's performance in Science was used as a benchmark for the selection of the two sections for the pilot study. 30 students were chosen from each of the two sections by picking the alternate name from the attendance register of that class in two runs. Students from one section were kept as one intact group. Hence two groups 1 and 2 were formed for the testing sessions. The total number of students in the pilot study comprised of 60 students in all ($n = 60$).

The investigator gave a brief introduction to the students that they were going to learn a lesson in Biology from Brand-I Software. A panel of two science teachers and one computer in-charge monitored the students in each batch. Fifteen students were accommodated in the Computer-Laboratory in each batch with one student for one multimedia system. Hence each student was able to learn at his own pace individually. Each learning session lasted for about 30 minutes. Students were allowed to repeat learning the lesson twice or thrice. Students who finished learning the lesson earlier than others were encouraged to revise it at their own pace. Students were not hurried to complete the lesson. Whenever any student asked for help, the Investigator and the staff members monitoring the learning session, provided assistance in operating the Computer. There were no requests from the students about the lesson content. A few students had difficulties related to computer operations which was quickly attended by the resource persons.
At the end of the learning session, a teacher made, paper-pencil objective type test was given to the students. The objective type test consisted of items such as true or false, multiple choice and fill up the blanks. The test was for 20 marks. Students were not required to finish the test quickly within a given time, as it was a "power test" and not a "speed test". The duration of the test lasted for about 20 minutes.

In the first phase, Group – I was exposed to lesson 1 by the C.A.I. method and Group – II was taught lesson 1 by the conventional method of Teachers Instruction (TI) in the classroom. By reversing the order in the second cycle, Group – I was taught lesson 2 by the conventional method of Teachers Instruction (TI) in the classroom and Group – II was exposed to lesson 2 by the C.A.I Method. The performance score of both groups I and II were combined methodwise and were statistically analyzed. Means and Standard deviation were calculated and paired ‘t’ test was applied to find if the differences in the performance was statistically significant.

**Presentation of the Data of Pilot Study I**

Towards comparing the performance of the students of the two groups, paired 't' test were applied. The details are given in the following table.

**Table 3.3**

<table>
<thead>
<tr>
<th>Group</th>
<th>C.A.I</th>
<th>T.I.</th>
<th>'t' value</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group-1 (n=30)</td>
<td>62.77</td>
<td>471.63</td>
<td>82.53</td>
<td>183.71</td>
</tr>
<tr>
<td>Group-2 (n=30)</td>
<td>60.20</td>
<td>177.20</td>
<td>78.73</td>
<td>178.82</td>
</tr>
</tbody>
</table>
Since the obtained 't' values are greater than the table value at 1% level of significance, the hypothesis 1.1 that the two methods of instruction are equal is rejected at 1% level of significance, in both the groups. The mean of C.A.I. is less compared to that under T.I. method. The pilot study results were quite contrary to several other research findings. The investigator felt that this may be due to 1) The inadequacy of the Brand-I Educational Software, 2) Lack of skills of students in the use of Educational Software. Towards ruling out the poorer performance under CAI as a function of these factors, the following steps were taken.

i. Inadequacy of Educational Software

Brand-I educational software used for the pilot study did not have an "Audio component" throughout the lesson. It had Audio-recording of only the introductory part of the lesson, after which the students had to read the text of the lesson from the screen, viewing the pronunciation and graphic effects while reading the lesson. Students who have reading difficulties may not be able to learn and perform in this manner. In such a case their poor performance in the C.A.I. method may not be due to the method of instruction per se. Hence the investigator decided that this disadvantage must be got rid of, in order to facilitate those students who had this difficulty in the experimental study.

ii. Lack of skills of students in using Educational Software

Even though the students in the pilot-study were given an orientation before the pilot-study it might not have been adequate to enable them to learn from Educational Software with ease and confidence. Hence it was surmised that, in order to familiarise the students with the method of learning from the educational software, another orientation program must be conducted before attempting to test the performance of the students resulting from C.A.I.
Selection of Brand II software:

Another brand of commercial software (Brand II) became available around June’97. It was evaluated as per the same criteria on which Brand I software had been evaluated. The independent rankings of the two brands on the 3 common criteria is presented below.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Domain</th>
<th>Rank</th>
<th>Brand I</th>
<th>Brand II</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Content Characteristics</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Instructional Characteristics</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Technical Characteristics</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.4

Domain-wise ranking of the two brands of software

Note:

The comparison of the two brands in the peculiar context of their study was superfluous in as much as use of the second brand was Hobson's choice: there was no third brand of software locally available at that point in time.

Orientation Programme - II:

Results of the pilot study led to orientation program II. Brand-II software which had just then been launched in the market, was tested by the Investigator and the same panel of five Science teachers from School I were selected for this experiment. The panel found that Brand-II Software had a "Voice component" throughout the lesson, and opined that students may not have any difficulty in learning from Brand-II software unlike with the Brand-I software, since the students can use a headphone which will enable them to hear the "Voice narration" of the lesson fully and hence this will facilitate their reading of the lesson as well. It is closer to the conventional method of teacher instruction where in the voice component is atleast as salient as the visual component if not more...
Orientation Program was conducted in the multimedia Laboratory of School-I. The investigator, a panel of four science teachers and two Computer-Laboratory Personnel from School I conducted the orientation programme. All the students from Standard V in School-I and those selected from school II were given this orientation. Students were tested in batches of 10 students each and every batch was monitored by the Investigator, two science teachers and one Computer-Lab in-charge, so that the Science teachers and Computer-Lab in charge could come in alternate shifts.

Instructions were given to the students by the investigator the same as in the Orientation Programme-1. Students learnt from the Brand-II educational software on a one student to one computer basis on their own, at their own pace. Each student used a headphone individually to hear the Audio track of the lesson, as they were proceeding to read the text of the lesson from the monitor of the Computer. The panel members monitoring the session provided help to the students whenever they needed assistance. The science lesson used for the C.A.I. method of learning, in the orientation programme - II was titled **Seed Germination**.

The students were given sufficient time to repeat the lesson twice or thrice. They were allowed to go back and forth with the lesson, as they were learning from the Brand II educational software just as they were allowed with Brand I software. At the end of the learning session students were given a Teacher made, paper-pencil, objective type test for 20 marks based on the lessons they had just learnt. Students were given adequate time to complete the test. This was done in order to ensure that they had sufficient experience of learning from educational software and writing a test immediately after the learning session, so that they can do this with ease in future learning and testing sessions on C.A.I.

**Pilot Study - II:**

Double-Group-Rotational Design was used for the Pilot Study-II as in the case of Pilot Study-I. The same panel i.e., the Investigator, four science teachers and two computer-lab personnel monitored the study. The same 60 students from Pilot Study-I were selected for
testing, in the Pilot Study-II. But since 2 students, one in each of the two groups were absent on the day of this study only 58 students participated in the Pilot Study-II.

Two science lessons of equal difficulty level were chosen by the same panel after going through all the lessons from the educational software as well as the text-book prescribed by the Central Board of Secondary Education for Standard V. The chosen lessons were as follows:

    Lesson-1 Photosynthesis
    Lesson-2 Parts of a plant

In the first phase Group I was exposed to lesson 1 by the C.A.I, method and Group II was taught lesson 1 by the conventional method of Teachers Instruction (TI), whereas in the second phase Group I was taught lesson 2 by the conventional method of teacher instruction and Group II was exposed to lesson 2 by the C.A.I, method.

The performance scores of both sections were pooled methodwise (namely C.A.I, and T.I. respectively) and were statistically analysed. Means and Standard deviations were calculated and 't' test was used to see if there was any significant difference in the performance of students due to the method of teaching.

The statistical summary of the data collected are given in the following tables.

**Presentation of the Pilot Study II**

Towards comparing the performance of the students of the two groups, paired 't' test was applied to test the significance of the difference between the two sample mean scores the details were as follows.
Table - 3.5
Means and Standard Deviations of Pilot Study II

<table>
<thead>
<tr>
<th></th>
<th>C.A.I</th>
<th>T.I.</th>
<th>‘t’ value</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard Deviation</td>
<td>Mean</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>Group-1 (n=29)</td>
<td>50.46</td>
<td>23.29</td>
<td>82.60</td>
<td>21.63</td>
</tr>
<tr>
<td>Group-2 (n=29)</td>
<td>71.18</td>
<td>18.66</td>
<td>72.32</td>
<td>19.69</td>
</tr>
</tbody>
</table>

The obtained ‘t’ value is greater than the table value at 1% level of significance for Group 1. It indicates that the performance level of the students in Group 1 under TI method is significantly higher than under C.A.I. However there was no statistically significant difference in the level of performance under the two methods in the case of students in Group 2 in other words TI is found to be superior than C.A.I. with one of the two groups and both methods are about equally effective in the case the other group.

To summarise finding of the pilot study so far:

In the first phase the level of performance of both the experimental groups was superior under T.I. method compared to C.A.I. method.

1. In the second phase the level of performance of one of the groups was superior under T.I. method compared to C.A.I. but that of the other was about equal under both the methods

2. An interphase comparison (comparison of phase I and phase II scores)
Table No.3.6
Comparison between Pilot Study-I and Pilot Study-II in C.A.I and Score Differential

<table>
<thead>
<tr>
<th>Section</th>
<th>Sample</th>
<th>Pilot Study-I</th>
<th>Sample</th>
<th>Pilot Study-II</th>
<th>Paired</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Size</td>
<td>Mean</td>
<td>S.D.</td>
<td>Size</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>A</td>
<td>30</td>
<td>62.63</td>
<td>21.77</td>
<td>28</td>
<td>50.46</td>
<td>23.30</td>
</tr>
<tr>
<td>CAI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TI</td>
<td></td>
<td>82.53</td>
<td>13.56</td>
<td>28</td>
<td>82.61</td>
<td>21.64</td>
</tr>
<tr>
<td>SDL</td>
<td></td>
<td>19.90</td>
<td>17.95</td>
<td></td>
<td>32.14</td>
<td>18.89</td>
</tr>
<tr>
<td>B</td>
<td>30</td>
<td>60.20</td>
<td>13.31</td>
<td>28</td>
<td>71.18</td>
<td>18.67</td>
</tr>
<tr>
<td>CAI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TI</td>
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<td>78.77</td>
<td>13.30</td>
<td>28</td>
<td>72.32</td>
<td>19.69</td>
</tr>
<tr>
<td>SDL</td>
<td></td>
<td>19.90</td>
<td>17.95</td>
<td></td>
<td>32.14</td>
<td>18.89</td>
</tr>
<tr>
<td>C</td>
<td>60</td>
<td>61.42</td>
<td>17.93</td>
<td>56</td>
<td>60.82</td>
<td>23.38</td>
</tr>
<tr>
<td>CAI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TI</td>
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<td>80.65</td>
<td>13.45</td>
<td>56</td>
<td>77.46</td>
<td>21.15</td>
</tr>
<tr>
<td>SDL</td>
<td></td>
<td>19.23</td>
<td>15.73</td>
<td></td>
<td>16.64</td>
<td>24.98</td>
</tr>
</tbody>
</table>

NOTE: SDL denotes Score Differential

Final Study:

The sample for the main study consisted of 210 students (114 Boys and 96 girls) of Standard V from two different schools from the city of Chennai. The sample from School I consisted of all the students from Standard V (n = 168) from four sections A, B, C and D. The sample from School II which consisted of 42 students (- boys and - girls) selected from five sections of Standard V namely A, B, C, D and E.

Two Biology lessons of equal difficulty level were chosen by the panel of teachers after scrutinizing all the lessons in Brand II educational software and the Science text-book prescribed for Standard V by the Central Board of Secondary Education. The lessons chosen were:

Lesson 1 - Seed Structure
Lesson 2 - Functions of parts of a plant
The data collection consisted of two stages:

**Stage I:** Conducting the experiment as per the chosen design, thus generating and collecting the primary data pertaining to the performance of the students under the two methods. This data relates to the dependant variable (performance scores) and treatment variations (namely C.A.I. and T.I.) and the score differential between them, which reflects the relative effectiveness of the two methods per se.

**Stage II:** Collecting the data pertaining to the groups of variables namely 1) Student-related Variables 2) Computer-related Variables 3) Environment-related Variables.

The data for the study were gathered in the following manner.

1. Administering Cattells' C.P.Q. (14.P.F) to study the personality profile of the students.
2. Administering the questionnaire developed by the investigator to collect information about the students regarding their family background, exposure to computer etc.

For the Qualitative aspect of the data to be obtained from the students, the following sessions were held:

1. Personal, face to face interactive sessions between the investigator and two groups of students selected on the basis of their score differential (i.e. those who gained most from CAI and those who gained least from CAI).
2. A focus-group discussion among the investigator, a panel of administrators, teachers and a few parent volunteers, whose children participated in the experiment. (The focus group discussion was conducted as per the methodology given by Zemke (1989).

**Stage I – Generating and collecting the experimental data:**

The Double-Group-Rotational Design was used for the main study. The experiment was conducted in two phases. The 210 students (116 boys and 94 girls) from the two schools were assigned to two groups. In the first phase group 1 (G-1) was exposed to lesson 1 by the C.A.I. method and group 2 (G-2) was taught lesson 1 by the conventional method of teacher instruction in the classroom. By reversing the order in the second phase, G-1 was
taught lesson 2 by the conventional method of teacher instruction in the classroom and G-2 was exposed to lesson 2 by the C.A.I. method.

The following table shows the order of presentation of the lessons methodwise:

Table No. 3.7

Experimental phases by Double group rotational design

<table>
<thead>
<tr>
<th>Phase</th>
<th>Lesson</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>C.A.I.</td>
</tr>
<tr>
<td>Phase I</td>
<td>L1</td>
<td>G1</td>
</tr>
<tr>
<td>Phase II</td>
<td>L2</td>
<td>G2</td>
</tr>
</tbody>
</table>

* L – denotes the Lesson
** G – denotes the group

As in the case of the pilot study Phase-I and Phase-II, a panel of teachers monitored the main study C.A.I. method of learning, along with the Investigator. The panel consisted of four science teachers and two Computer-Laboratory Personnel from School I and Two Science teachers and one Computer-Science teacher from School II. Students were accommodated in the multimedia-laboratory of School I in batches with fifteen students per batch. Each batch of students were monitored by the Investigator, two Science Teachers and one Computer-Lab in-charge so that teachers could come in alternate shifts.

For instructions under the CAI method, these students were accommodated in the multimedia laboratory of school I in batches of fifteen students per batch. For the conventional TI method each section from school I was kept as one intact class and Group 1 and Group 2 from school II were kept as two separate classes.

In all the C.A.I. learning sessions, students were made to learn on a 'one student- to one computer' basis. Hence all the students learnt under C.A.I. individually, each on his/her own and at his/her own pace. Each student used a "Headphone" to hear the "voice-recording" of the lesson and read the text of the lesson from the monitor of the Computer. Students proceeded with the lesson by moving the "mouse" of the computer on the mouse-
pad in order to click on the "arrow" indicated on the monitor. The right arrow (\(~\rightarrow\)) was used for proceeding ahead with the lesson and the left (\(<\sim\)) was used for going back to the earlier part of the lesson, in case the student had any doubt and wanted to learn that part of the lesson again. Since all the students had been given orientation twice for Brand II software, they did not have any problem in proceeding with the lesson under C.A.I, method. Students who finished learning the lesson earlier than others were allowed to revise it at their own pace.

Each of the learning sessions in C.A.I, method lasted for 40 minutes during which time the students were allowed to go back and forth with the lesson in Brand-II educational software. Most of the students had revised the lesson thrice, while a few could revise the lesson only twice, depending on the pace of their learning.

In order to maintain parity between the duration of the two methods of instruction the conventional Teacher Instruction Method was kept as 40 minutes. The teacher would teach the lesson for 30 minutes using the blackboard in the classroom and two teaching-aids (a specimen and a chart) without any interruption from the students, at the end of 30 minutes she revised the lesson for about 10 minutes by asking questions and eliciting answers from the students.

At the end of each of the learning sessions for both methods (C.A.I and T.I) a teacher made, paper-pencil objective type test was given to the students. The objective test consisted of test items such as True or False, Multiple Choice and fill up the blanks, (The objective type test paper is given in the appendix.) As it was only a Power-test and not a Speed-Test, students were not hurried to finish the test. They were given sufficient time to complete the test. Nevertheless the duration of each test sessions lasted for about 20-25 minutes.

The conventional method of teacher instruction in the classroom was streamlined for the purpose of the study towards ensuring uniformity of treatment for all the sample sub groups by giving necessary instructions.
The investigator was a silent observer in each of the TI class room sessions which were held serially such that the investigator could be present in each one of them and also tape record the class room transactions.

Immediately after each of the TI sessions the teacher made objective type pencil test was administered. Since it was the objective type test in which the answers were filled in by the students on the test booklet itself and was collected immediately by the teacher/investigator from the students.

Since the T.I class sessions were conducted in quick successions without any interval between the sessions, confidentiality of the test items could be ensured.

The performance scores of all students from School I and School II were pooled methodwise (namely C.A.I and T.I respectively) and were statistically analysed. Paired 't' test, 'F' test, Pearson's product moment correlation and factor analysis, were applied.

Stage 2 involves collecting the data through two distinct strategies. Strategy 1 comprises collecting the background information about the students by means of a questionnaire developed by the investigator and the data relating to the personality of the students by Cattell's CPQ (14 P.F).

**Cattell's C.P.Q. (14-P.F.)**

The investigator used Forms Bj and B2 of Cattell's Personality Inventory (14-P.F) for the present study. Each of the forms consist of seventy items for testing the personality of students. The investigator gave instructions to the students as prescribed in the manual of this test and explained to the students as to how to answer the test items with examples. After the explanations, the students were allowed to answer the test items. Each of the test items was read out by the investigator from the Form, while the students made a 'x' mark in the boxes that correspond to that particular item in their respective answer sheets. The students were encouraged to seek clarifications for their doubts if any, from the investigator.
and the class teacher of the corresponding section while filling up the forms. Forms B] and B2 were administered to all the 210 students in two sessions on two different days. Students took approximately an hour to fill up each of the forms.

The data were thus collected from all the students on the 14 personality traits namely A,B,C,D,E,F,G,H,I,J,Qi,Q2,Q3 as tested by the Forms Bj and B2 of the C.P.Q inventory. The investigator followed the scoring procedure as given in the C.P.Q manual for calculating the scores of all the students on each of the individual traits. Pearson's product moment correlation was applied to test the relationship between the chosen personality traits of the students and their respective score differentials between the two methods of instruction.

Administering the questionnaire developed by the investigator:

The investigator administered the questionnaire to all the 210 sample subjects section-wise, with the help of the respective class teachers. Students were given instruction as to how to fill up the questionnaire with sample questions written on the black board. Students had to put a tick ( V ) mark inside one or more of the boxes in a horizontal row against each question as applicable to his/her case. The investigator and the class teachers went up to each row of students, explained and clarified the questions if the students needed help while filling up the questionnaire. The time taken by each batch of students to fill up the questionnaire was about 50 minutes to an hour. The data collected from the questionnaire were analysed item-wise using appropriate statistical techniques.

Collection of Qualitative Data: The qualitative data was collected through face-to-face interaction between the investigator and the selected students, and a focus-group discussion among a panel of administrators, teachers and parent volunteers which are presented hereunder:

Investigator-student interactive sessions:

The investigator selected fifteen students who have gained most from C.A.I method of learning (Group A) and fifteen students who have gained the least from the C.A.I method of
learning (Group B) based on the results of the study (after consolidation of their performance scores method-wise).

The investigator conducted two student interactive sessions, one with group A and another with group B separately. Group A students (those who gained most from C.A.I method of learning), were made to work in the Computer- Laboratory of School-I on a one-computer-to-one student basis using a headphone as in the case of the earlier experiment. The fifteen Multi-Media systems were booted with a lesson from Brand-II software, through the server connected to the network of computers in the laboratory for the students to learn from the C.A.I method of instruction. Students were allowed to go back and forth with the specific lesson they were learning, as they pleased. They were encouraged to repeat learning the lesson when they finished once. The rationale for requiring the students to repeat learning the lessons through C.A.I. was to refresh their memory. The session lasted for an hour during which time most of the students had learnt the lesson thrice and a few of them had learnt the lesson twice. Immediately after the learning session, they were seated in the adjoining room for an interactive session. The investigator gave the following instructions to the students:

Box-3
Instructions to Students before Student-Investigator Interactive Sessions

"We are going to have a discussion on the computer-assisted-method of learning, which all of you have got exposed to a few times during the course of the academic year. I will ask you a few questions about learning lessons from the computer and learning from a teacher in a classroom. Please give your frank opinion as to what you think of the specific question. There is no right or wrong answer. All of you will be considered correct, as it is your individual viewpoint. Please do not answer in chorus. Each one of you will be given a chance to answer each question. Please feel free to participate in the discussion."

After giving the instructions, the investigator started asking a few questions to elicit the students' opinion on the C.A.I method of learning. As the students started answering, each one of the answers was written on the black-board and further discussed by asking all the
students to add on more to what was said earlier by others. The investigator tape-recorded
the proceedings of the entire session. One science teacher who helped the investigator to
conduct the session made notes of the entire session to keep track of the proceedings.

The questions were thrown to the group as a whole but the students were instructed to raise
their hands individually whenever they wanted to answer a particular question. The hands
were counted question wise and recorded.

The session envisaged the following questions:

**Box-4**

List of Questions to Students during Student-Investigator Interactive Sessions

1) **How many of you like/dislike to learn by the C^I. method of learning?** Give reasons for your
   answer. **Which aspects of the CAI method did you like?** Which aspects of the CAI did you
dislike?

2) **How many of you like/dislike to learn by the T. I. method of learning?** Give reasons for your
   answer. **Which aspects of the T.I method did you like?** Which aspects of the T.I did you dislike?

3) **How many of you like to learn by the C.A.I method first and get reinforced the same lesson ii
   the classroom by the teacher?** Give reasons for your answer.

4) **How many of you like to learn by the T.I method first and get reinforced by the CAI method?**
   Give reasons for your answer.

5) **How many of you feel that you can perform better in a test and score more marks after
   learning by the CAI method?** Give reasons for your answer.

6) **How many of you feel that you can perform better in a test and score more marks after
   learning by the T.I method?** Give reasons for your answer.

7) **Do you have any difficulty in operating the Hardware/Software due to which you are not able
to learn properly under the C.A.I method of instruction?** If so explain with an example from
   your experience.
The same procedure was adopted by the investigator for conducting the interactive session with the fifteen students from group 'B' (that is, those students who have gained the least from the C.A.I method of learning. As in the earlier session, the discussions of the entire session were tape-recorded and a teacher helped the investigator by keeping notes of the proceedings of the entire session).

All the information gathered from the two groups of students were consolidated from the teacher notes as well as the tape recordings of the sessions. They were drafted, synthesized item-wise and analysed by the investigator. The findings of the two sessions are presented in the R & D Chapter as narrative text after the presentation of the quantitative data and relating the two wherever and as far as it had been possible.

Focus-Group Discussion:
The investigator conducted a Focus Group Discussion to obtain the opinions from a group of parents, teachers and school administrators on the effectiveness of C.A.I method of learning with reference to students' performance in science. This was done in order to arrive at some possible unanimity, among the three groups of people involved, about the reasons for the C.A.I being as effective as T.I method.

The group consisted of nine persons in all—three were school administrators, three were teachers and three were parents, whose children had undergone the C.A.I experiment.

The investigator prepared an interview outline for conducting the Focus Group Discussion (Refer Appendix). This was done in order to make clear to the group, the purpose of the meeting and the kind of information the investigator was seeking from them so that the participants could focus their discussion on the issues concerned and not digress from them.

The Focus Group Discussion was conducted in the classroom, adjoining the computer laboratory in School-I. The investigator gave a brief account of the experiment conducted in the school, in order to familiarise the participants with the research study, and then she
explained to them the purpose of the present meeting. She wrote the interview outline on the white-board in the classroom, so that it would help the participants to pick up the points and discuss them one after another.

The investigator initiated the discussion and then let the participants give their individual views on each of the points. The investigator listened and "went with the flow" of the discussion.

All the participants were encouraged to participate in the discussion. One of the teachers made notes of the entire discussion while the investigator tape recorded the proceedings. The session lasted for about an hour.

After the first round of discussion was over the participants were made to view a science lesson from Brand II software, on a one person to one computer basis. The investigator, two science teachers and one computer laboratory personnel went to each of the participants and helped them with computer operations whenever they needed assistance. The participants were free to go back and forth with the lesson and repeat learning as they wished. This C.A.I laboratory session lasted for an hour.

The participants were made to gather in the room adjoining the computer-laboratory (where the first round of discussions took place). The investigator initiated the second round of discussions on the reactions of the participants after having gone through a learning session on C.A.I. This was done in order to compare their initial reactions to C.A.I before experiencing it, with their reactions to the same after experiencing it. Just as in the case of the first round of discussions, the participants were encouraged to discuss the issues based on items of the interview outline in the second round as well.

After all the items of the interview outline were completed, the investigator asked the participants to come up with their individual comments and suggestions which had not been covered by the interview outline. This gave the participants an opportunity to share their
own feelings/experiences about C.A.I., which they have been holding back so far. This provided some additional information on the topic of C.A.I and its effectiveness on the performance of students. Just as in the first round of discussions, the second round of discussions were tape recorded and one of the teachers transcribed the entire session. The information collected from the two rounds of discussions were analysed and synthesized by the investigator, by listening to the tapes and by editing the transcriptions for meaning, in tandem. The investigator organised the qualitative data thus collected by processing and analysing the "content".

The findings from the Focus Group Discussion are presented as narrative text in the chapter on Results & Discussions after the presentation of the quantitative data and relating them to the qualitative data, wherever feasible and relevant.