CHAPTER IV

METHODOLOGY
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METHODOLOGY

4.1 INTRODUCTION

The preceding chapters have brought out the need and significance of a study of this kind.

4.2 THE PROBLEM

The current investigation is on "Development and Validation of Computer Assisted Instruction" in Physics for High school students.

4.3 OBJECTIVES

The main objective of this study is to examine the relative effectiveness of Computer Assisted Instruction over traditional method of teaching on the achievement in Physics.

The specific objectives are:

(i) To develop a suitable software on the selected topic "Electricity" for Class IX and validate it.

(ii) To study the effect of Computer Assisted Instruction on learning the concepts in the topic 'Electricity' in Physics.

(iii) To analyse the variation among the students in the acquisition of various cognitive skills by learning through Computer Assisted Instruction.
(iv) To study the relationship between achievement in Physics learnt through Computer Assisted Instruction and Intelligence of the students.

(v) To find out the relation between students' attitude towards science and their achievement in learning through Computer Assisted Instruction.

4.4 VARIABLES SELECTED FOR THE STUDY

The dependent variable selected for the study is the achievement of the students in Physics. It refers to the achievement of students in Physics as shown by the scores in the post-test.

The two different methods of teaching i.e., traditional method of teaching and teaching through Computer Assisted Instruction form the two levels of the independent variable on which the achievement of students in Physics in the post-test depends.

The other independent variables are

(i) General Intelligence

(ii) Attitude towards science.

4.5 CHOICE OF COMPUTER

Mangal S.K. (1985) has listed the desirable features of a computer for use in science teaching. They are:

(i) Large Memory.

(ii) Use of Standard BASIC with enhancements for easy graphics handling.
(iii) High resolution Color Graphics for diagrams.
(iv) Simple sound capabilities.
(v) User port for 'Control' experiments.

The BBC Micro model B more than satisfies these requirements. In addition, it provides an excellent 'Structured' version of BASIC. Other features are the excellent keyboard, the simple but efficient editing facilities, the user defined function keys and the superb teletext mode. Besides, many schools are equipped with the BBC Micro model B, due to Computer Literacy Awareness (CLASS) programme. No air conditioning is required, only fan cooling is necessary. Being a hardy and rugged computer, it is able to withstand use by a large number of students.

The investigator after working on several machines, opted for this computer due to its graphic capabilities, easy availability and versatility.

4.6 CHOICE OF PROGRAMMING LANGUAGE

Software suitable for use in this computer was developed by the investigator in BASIC.

(i) BASIC is a well documented, well used language fully supported by the BBC Micro model B.
(ii) The basic structure of the language makes programming and debugging a relatively easy task.
4.7 DESIGN OF THE STUDY

The following flowchart explains the steps involved in the design of the study.

Flowchart 1

RESEARCH DESIGN

1. Selection of School, Class, Subject and Topic
2. Sample Selection
3. Classification of Experimental and Control Group
4. Selection of Topic of the study
5. Pre-Test in the topic chosen
6. Prepared Computer Programme for the topic selected in 'Electricity' in the subject Physics for Class IX.
7. Control Group taught through traditional method.
8. Experimental Group taught through Computer Assisted Instruction.

A
4.7.1 SELECTION OF SCHOOL, CLASS, SUBJECT AND TOPIC

The subject matter was identified along with the educational level of the target students. The topic 'Electricity' in Physics was selected as it was said to be more difficult for students compared to the other units in Physics, by Physics teachers handling Class IX in all the three schools namely Kendriya Vidyalaya Coimbatore, Kendriya Vidyalaya Sulur and Sri Padmavathy Ammal Matriculation School, Coimbatore.

4.7.2 SAMPLE

The students involved in the study were in the ninth standard of Kendriya Vidyalaya, Coimbatore, Kendriya Vidyalaya, Sulur and Sri Padmavathy Ammal Matriculation School, Coimbatore.
and Sri Padmavathy Ammal Matriculation School were equipped with BBC Micro model B.

Sampling methods can be classified into two broad categories

(i) Non-probability Sampling and

(ii) Probability Sampling

In non-probability sampling as explained by Lokesh Koul (1984) the units are selected at the discretion of the researcher. Such samples derive their control from the judgment of the researcher. If he is to select a sample of 200 school students, he may exercise his own judgment based on experience for including a given student in the sample. The sample so selected is called a judgment or purposive sample. Such a sample is arbitrarily selected because there is a good evidence that it is a representative of the total population. The evidence is always based on the experience.

The investigator has selected this technique of sampling for adoption in the study.

4.7.3 CLASSIFICATION OF EXPERIMENTAL AND CONTROL GROUP

115 students of Class IX of Kendriya Vidyalaya, Coimbatore are taken as experimental group A, 38 students of Class IX of Sree Padmavathy Ammal
Matriculation School as experimental group B and 89 students of Class IX of Kendriya Vidyalaya, Sulur as Control Group C.

Some of the concepts in the topic 'Electricity' that are not included in the CBSE syllabus are also taken while preparing the program to see whether these concepts can be learnt by CBSE students.

Computer Assisted Instruction being an individual learning programme, five students per session would report at the computer room, to work on the five computers. Everyday it was possible for 10 students to work on the Computer Assisted Instruction material.

Similarly, students of Sree Padmavathy Ammal Matriculation School were allowed to work on the computer individually, 3 students per session.

4.7.4 PRE-TEST IN THE TOPIC

A pre test on the topic 'Electricity' was given to check their previous knowledge in the particular topic before the start of the lessons to all the three groups. The test consists of seven one mark questions, and nine two mark questions. The question paper was prepared based on the blueprint prepared providing for Knowledge, Understanding, Application and Skill having 32%, 28%, 24%, and 16% of the marks respectively. The time...
duration was 25 minutes and maximum marks was 25. This was a paper-pencil test.

4.7.5 DEVELOPMENT OF SOFTWARE

After it was decided to use the BBC micromodel, the investigator used the CLASS lab of Kendriya Vidyalaya, Coimbatore.

The topic 'Electricity' was divided into five units as follows:

(i) Nature of Charges
(ii) Electric Potential
(iii) Electrical Devices
(iv) Combination of Resistors
(v) Heating Effects of Current

Each unit was given the filename as ELECTY1 ELECTY2, ELECTY3, ELECTY4, ELECTY5. All the above units were explained frame by frame using different colours to represent the positive and negative charges, electrical devices like Ammeter, Voltmeter. Sound effect was given to show the movement of electrons along the electrical circuit. The strength of the force i.e., attractive and repulsive between the two charges was shown with animation effect.

The preparation of frames for the package has been done in the following manner:
**Small Steps:** Each concept is presented in a sequence of small learning steps to allow the students to understand well before they proceed to the next frame.

**Immediate Feedback:** To allow the learner to realise whether he/she is right or wrong after each response, immediate feedback is given with the help of keys P - Previous Page, N - Next Page, G - Graphs, C - Circuits, M - Menu etc. Sequencing has been kept logical and straightforward.

Illustrations are given with the proper use of Colours, Sound and Animations.

<table>
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<th>Floppy Label</th>
<th>Programme Stored</th>
<th>Operation Mode</th>
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<tr>
<td>1.</td>
<td>Nature of Charges</td>
<td>ELECTY 1</td>
</tr>
<tr>
<td>2.</td>
<td>Electric Potential</td>
<td>ELECTY 2</td>
</tr>
<tr>
<td>3.</td>
<td>Electrical Devices</td>
<td>ELECTY 3</td>
</tr>
<tr>
<td>4.</td>
<td>Combination of Resistances</td>
<td>ELECTY 4</td>
</tr>
<tr>
<td>5.</td>
<td>Heating Effects of Current</td>
<td>ELECTY 5</td>
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<td>6.</td>
<td>Interim Test 1</td>
<td>QUEST 1</td>
</tr>
<tr>
<td>7.</td>
<td>Interim Test 2</td>
<td>QUEST 2</td>
</tr>
<tr>
<td>8.</td>
<td>Interim Test 3</td>
<td>QUEST 3</td>
</tr>
<tr>
<td>9.</td>
<td>Interim Test 4</td>
<td>QUEST 4</td>
</tr>
<tr>
<td>10.</td>
<td>Interim Test 5</td>
<td>QUEST 5</td>
</tr>
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</table>

The above five units in the topic 'Electricity' was taught through traditional method for Control Group.
4.7.6 PILOT STUDY

The software developed, and the post tests were trial tested using students of a high school other than that taken for the sample.

A pilot study was conducted using ten students. As this study is an individual learning experiment, the investigator had to chart out a time table without disturbing the other classes with the teachers concerned.

The students chosen were allowed to use the computer during the lunch break and some after the school hours apart from their regular Physics period.

The software originally developed by the investigator had to be restructured introducing the suggestions given by the students in the pilot study. The students gave suggestions regarding the use of brighter colors and use of sound effects.

In the first unit 'Nature of Charges' the students felt that the diagram showing the lines of force due to a positive and negative charge can be shown instead of directly going into the diagram of lines of force due to two unlike charges separated by a distance. Keeping this in mind, the investigator introduced the diagram of lines of force due to positive and negative charge.
Students enjoyed the program, especially the pattern of lines of force due to a dipole i.e., unlike charges separated by a small distance as it was drawn with flashing different colors, animation and sound.

Unit II 'Electric Potential' did not pose any problem. All the students fared well in it.

In Unit III 'Electrical Devices' students felt that the direction of electric current can be shown with the movement of charge carriers i.e., electrons along the path of the electric circuit especially in the circuit of verification of Ohm's Law.

Accordingly, the investigator introduced the movement of electrons with flashing red color and with sound effect.

Unit IV and V was a success. All of them enjoyed the program and learnt the skill of connecting the components in the electrical circuit.

Taking note of all these points, the investigator modified the software. Instructions to the students were given explicitly to avoid ambiguity. The important points in this unit were highlighted by flashing colors.

The revised version of the software was used in the final testing.
4.7.7 CONSTRUCTION OF INTERIM TEST AND POST TEST

Interim Test: Five interim tests were conducted one for each sub unit on the topic 'Electricity'. All these tests were incorporated in the floppy disk itself and has been dealt in detail under software development of each unit.

Students answered by pressing the appropriate keys and the scoring was done by the computer itself. If the response is incorrect, the correct answer is displayed on the screen and then they proceed to the next question.

There are 10 questions in each unit divided as 2 under multiple choice, 3 under fill up the blanks, 3 True or False and 2 reasoning questions. Each question carries 1 mark and the total mark for each unit is 10.

Color and sound have also been incorporated in the above tests.

Post-Test: This is a paper and pencil test. This test was based on all the five units on the topic 'Electricity' and was prepared according to the blueprint.

It contained seven 1 mark and nine 2 marks question. The Average time takes was 45 minutes and Maximum marks was 25. Question paper was prepared according to the Blue print including knowledge (32%), Understanding (28%), Application (24%), Skill (16%) questions.
Content Validity

The content validity of these tests was assessed by a panel comprising subject specialist teachers, educators and computer professionals. Subject specialist teachers were Physics teachers teaching Physics at secondary level. The computer professionals were from the CLASS lab of PSG College of Technology, Coimbatore.

4.8 HYPOTHESIS

The following hypotheses have been formulated keeping in mind the theoretical framework, the research findings and the paucity of studies in the use of Computer Assisted Instruction in the teaching of Physics.

(i) There will be significant difference in the achievement between the students who learn through Computer Assisted Instruction and through traditional method.

(ii) There will be significant difference in the acquisition of various cognitive skills of students learning through Computer Assisted Instruction and through traditional method.

(iii) Students learning through Computer Assisted Instruction and traditional method differ in their achievement in different units in the topic ‘Electricity’.

(iv) There will be significant relationship between achievement of students learning through Computer Assisted Instruction and their intelligence.
There will be significant difference between the attitude towards science who learn through Computer Assisted Instruction and through traditional method.

4.9 METHOD

The different stages of investigation are as follows:

(i) Software on the topic chosen, suitable for the BBC Micro model B was first developed.

(ii) A general test (Pre-test) in the lesson 'Electricity' was constructed by the investigator to see whether the students of the three selected schools were of the same population.

(iii) The Experimental groups learnt through Computer Assisted Instruction and the Control group through traditional method.

(iv) Post test was constructed according to blueprint.

(v) A questionnaire was administered to see the attitude towards science.

(vi) Administration of Culture fair test scale 2 to measure intelligence.

(vii) In addition to the post test, interim tests were administered after each sub unit.
4.10 DISCUSSION OF THE TOPIC

The topic 'Electricity' is divided into the following units.

(i) Nature of Charges.
(ii) Electric Potential.
(iii) Electrical Devices.
(iv) Combination of Resistors.
(v) Heating effects of Current.

The above five units have been discussed separately in the following order.

(i) Instructional Objectives.
(ii) Content Analysis.
(iii) Terminal Behaviour.
NATURE OF CHARGES

This unit is presented in a computer program which begins with the 'Menu' of the above. The following flowchart explains the operational procedure of the unit.

Flowchart: Operational Procedure of Unit 1

Start

Menu

Read Menu Choice MD

If MD=1

Introduction

If MD=2

Coulomb's Law

If MD=3

Electric Field

If MD=4

Lines of Force

If MD=5

Summary

If MD=6

End

Display Topic

Display Unit Choice UD

P, N, D, G, C, M

If UD='P'

Display Previous

If UD='N'

Display Next

If UD='D'

Display diagram Page

If UD='G'

Display graph Page

If UD='C'

Display circuit

If UD='M'

Go to Menu

Stop
INSTRUCTIONAL OBJECTIVES

The objectives of this unit are:

(i) To identify the type of charges that exists in nature and to know the force between them.

(ii) To state and use Coulomb’s Law of Force

\[ F = \frac{KQ_1Q_2}{r^2} \]

(iii) To define electric field at a point.

\[ E = \frac{\vec{F}}{Q} \]

(iv) To draw lines of force due to a single charge and due to two unlike charges separated by a small distance.

(v) To summarize the properties of lines of force from the diagram.

Content Analysis: The student should be able to explain the following concepts.

(i) The attractive and repulsive force between the unlike and like charges in nature.

(ii) Measurement of force between the charges using Coulomb’s Law.

(iii) Lines of force pattern due to positive, negative and both the charges separated by a small distance.
(iv) Properties of lines of force and concepts of electric field.

NOTES ON THE PROGRAM

(i) The introductory text begins with the nature of charges available, their production, and type of force that exists between them. The relevant diagrams are drawn using different colors and animation and sound effect.

(ii) In the statement of Coulomb's law, the relationship between the force between the charges, the magnitude of charges and the distance of separation between them are explained using the relevant expression.

(iii) The concept of electric field is defined on the basis of lines of force due to a single charge as well as with the relation between electric field and force.

(iv) Lines of force are defined and drawn due to the unlike charges.

(v) From the diagram, the properties of lines of force are summarized. Different colors, animation and sound effect are used in drawing the lines of force.
TERMINAL BEHAVIOUR

After exposure to this program, the student should be able to

(i) Understand the basic charges in nature.

(ii) Comprehend the formula in Coulomb's law and electric field.

(iii) Apply the above formula in solving problems and find the units of the physical quantities involved.

(iv) Appreciate the pattern of electric lines of force.

From this we can conclude that Instructional Objectives have been achieved in the above unit.

Similarly for the other units also the Computer Assisted Instruction software were prepared, details of which are given as Appendix.
The flowchart given here explains the process involved in interim the tests.

Flowchart 3: Operational Procedure of QUEST1
4.11 TOOLS USED

(i) Computer programming on the topic ‘Electricity’ in Physics for Class IX prepared by the investigator.

(ii) Culture fair test scale 2 published by Institute for Personality and Ability Testing, USA 1973 by Cattel.


(iv) Interim test (Unit Wise) in the topic to assess the terminal behaviour of the students, prepared by the Investigator.

(v) Achievement test in the topic to assess the cognitive abilities of the students prepared by the Investigator.

4.12 INTELLIGENCE TEST

Cattell’s Non-Verbal Intelligence test scale - 2 for the age group +14 is administered to assess the IQ level of the students. This test consists of four tests. The first test has 12 items, the 2nd test has 14 items and the other two have 8 items each. To make the students understand and familiarise the pattern of the test, two or three examples are given for each test.

Standardised norms are available to rate the student’s IQ level. There are two forms Form A and Form B. Both forms are non-verbal. Either one or both can be used to measure the IQ of the students. There is time limit to each test. It ranges from 2 minutes to 4 minutes. Within 12 minutes the test
can be completed. The Investigator used only one of these forms to measure the IQ of the students.

The validity and reliability of this standardised test have been established and this test being a culture fair test has been used in many investigations to measure the intelligence of the students in Indian context. (Vimala Devi (1985), B. Rajeswari (1987).

4.13 SCIENCE ATTITUDE SCALE

Under the new curriculum science is a compulsory subject up to high school stage. One of the objectives of teaching Science is to inculcate scientific attitude among the pupils. The purpose of this scale would be to know whether or not the students have developed favourable attitude towards science as a discipline.

Science attitude is an opinion or position taken with respect to a psychological object in the field of science (Richard W Moore 1970). So it is operationally defined as a generalised attitude towards the universe of science content and being measured in terms of its favourableness or unfavourableness estimated from the scores obtained on the attitude scale towards science. In this study the scale prepared by Avinash Grewal (1977) has been used to study the students' attitude towards science.
The scale was prepared based on the criteria mentioned by Edward (1975). Finally there were 20 items after dropping the least discriminating items.

**Scoring:** Likert's five point scale is used and weightages are assigned. Each of the ten positive items of the scale are assigned a weight ranging from 4 (strongly agree) to zero (strongly disagree). In case of ten negative items the scale scoring was reversed ranging from zero to 4. The attitude score of a subject is the sum total of scores on all the twenty items of the scale. Thus a maximum of 80 scores can be obtained by the subject.

**TIME FOR ADMINISTRATION**

The Science Attitude Scale is a self reporting inventory consisting of 20 items designed to assess the attitude of individual. The student requires 15 minutes for giving responses to the items of the scale.

**Reliability:** The reliability of Science Attitude Scale was estimated by split half method as 0.86 and by the test-retest method as 0.75 which was found to be quite satisfactory.

**Validity:** The Science Attitude Scale is a dependable tool for measuring student's attitude towards science. The Science Attitude Scale appears to have content validity. In addition, differences in mean scores were found among the selected groups of known preference for science. Arts (Mean =
46.41) and Science (Mean = 50.58). Students which differs significantly (t = 6.62) at 0.01 level.

4.14 THE EXPERIMENT

The Experiment can be divided into three stages - input, process and output.

**Input Stage**

**Input**

- Instruction on how to run the program.
- Details of topic to be covered.
- Post test on the topic 'Electricity' after the exposure to the computer programme of the complete five units.
- Score sheet to be filled by the investigator, as the scores are displayed on the monitor after exposure to the five interim tests.

The details contain the following:

(i) Instruction on how to run the program.

(ii) Details of topic to be covered.

(iii) Post test on the topic 'Electricity' after the exposure to the computer programme of the complete five units.

(iv) Score sheet to be filled by the investigator, as the scores are displayed on the monitor after exposure to the five interim tests.
Process

After completing each unit, students answered the questions given and the computer displayed the score obtained by the student. This is entered by the investigator in the sheet.

Post test is conducted in all the five units at the end of the topic which is a paper-pencil test.

Steps involved in the output

Output

Assessment of achievement using appropriate criterion

Evaluation using appropriate statistical analysis
The scores obtained by the student in each test is tabulated. Appropriate statistical analysis of the variables is then done.

4.15 STATISTICAL ANALYSIS

The statistical analyses of the study have been done in the following order:

(i) Categorisation into groups - Experimental and Control Group.

(ii) Relation between Post Test scores and IQ.

(iii) Significance of difference between two correlated means using gain scores.

(iv) Effect on Unit Wise achievement.

(v) Effect on cognitive skills and their interaction.

(vi) Correlation analysis between

   (a) Achievement test and IQ.

   (b) Attitude towards science and IQ.

4.16 CONCLUSION

To carry on these analyses apart from measures of central tendency, 't', 'F' and 'r' statistics were used.