METHODOLOGY

CHAPTER 3

METHODOLOGY

• Selection of Variables
• Objectives
• Hypotheses
• Procedure
METHODOLOGY

The methodology followed at the various phases of the investigation is described in this chapter and is presented under the following sections.

3.1 SELECTION OF VARIABLES
3.2 OBJECTIVES
3.3 HYPOTHESES
3.4 PROCEDURE

3.1 SELECTION OF VARIABLES

The review of related studies provided the investigator a clear idea of the theoretical outline of Concept Attainment Model of Teaching and Studying Approach. It helped the investigator to identify the independent variables, the dependent variable and the variables to be controlled. The methods of teaching and the studying approach of the learner are directly related to academic achievement. The academic achievement of the learner is also influenced by his/her intelligence and previous knowledge of the subject matter. In order to find out the exact effect of methods of teaching and studying approach on academic achievement, the effect of these variables should be controlled. Considering all the above points, variables which are related to achievement in physics were selected and
categorised for the study. A brief description of the variables selected for the study is given below.

3.1.1. Independent Variables

Two sets of variables based on methods and paradigms of teaching and a set of variables based on studying approaches were selected as independent variables.

The independent variables based on teaching paradigms are the two methods of teaching. They are as follows:

(i) Concept Attainment Model of Teaching
(ii) Objective Based Instruction

The independent variables based on approaches to studying are the three studying approaches as given below.

(i) Deep Approach
(ii) Surface Approach
(iii) Strategic Approach

3.1.1.1. Concept Attainment Model of Teaching

Concept Attainment Model is a model of teaching belonging to the information processing family of models. It has been developed based upon the studies made by Bruner and his associates (1967) about the
nature of concepts and the strategies of concept formation. It develops the ability of concept formation without any error. According to Siddiqui and Khan (1991), the concept attainment strategy, as a model of teaching, is concerned with two separate but related ideas: the nature of concepts themselves and the thinking process used by individual to learn concepts. Concept Attainment Model has been designed to enrich the students on specific concepts and the nature of concepts. They also provide practice in inductive reasoning and opportunities for altering and improving students' concept-building strategies. Specially with abstract concept, the model makes the learners aware of alternative perspectives, sensitive to logical reasoning in communication and tolerate of ambiguity. Many studies in India and abroad reveal that the concept Attainment Model as an instructional strategy helps in fostering information processing abilities of the learner and helps the slow learners and backward students in getting higher achievement.

3.1.1.2. Objective Based Instruction

The second method of instruction used for the study was Objective Based Instruction. It is based on Bloom's Taxonomy of Educational Objectives modified and adopted by National Council of Educational Research and Training. It was one of the methods adopted by
Government of Kerala in the primary and secondary schools and was recommended by Department of Public Instruction.

3.1.1.3. Studying Approach

Studying Approach refers to the individual approach of the students to the tasks prescribed by their course of study. Approaches to studying cover students' motives, conceptions, intensions and their interrelationship to distinct learning outcomes (Marton, 1976). The choice of studying approach is affected by the conditions in which the individuals learn. 'Studying approach' refers to orientation of pupils in studying, into which different strategies of learning and associated forms of motivations are merged (Marton and Saljo, 1976; Svensson, 1977). Measuring students' studying approach had been seen as a means of encouraging a more systematic approach to academic teaching (Katz and Henry, 1988). Tait and Entwistle (1996) had investigated the importance of measurement of studying approaches in identifying students at risk through ineffective study strategies.

3.1.2. Dependent Variable

Dependent variable selected for the present study is Achievement in Physics. The focus of the present study was to explore the combined effect of Concept Attainment Model and Studying Approach on Achievement
in Physics and retention over a period of time. Achievement in the cognitive domain was only considered for the study. All the categories under cognitive domain were included in the study. The categories are listed below: (i) Knowledge (ii) Comprehension (iii) Application (iv) Analysis (v) Synthesis (vi) Evaluation.

3.1.3 Control Variables

Control variables selected for the present study are the following:

(i) Previous Knowledge of the Subject Matter
(ii) Non-Verbal Intelligence

3.2. OBJECTIVES

The present investigation was intended to explore whether Achievement in Physics vary when concept Attainment Model of teaching is adopted in conventional classrooms without disturbing very much the usual classroom organisational set up. The study was therefore designed as a quasi-experimental study. The design adopted was Pre-Test-Post-Test Equivalent Groups design.

'Concept Attainment Model' has been selected as the Experimental Variable. The changes in Achievement in Physics if any have been explored in comparison with 'Objective Based Instruction'. Other variables namely 'Previous Knowledge of the Subject Matter' and 'Non-
Verbal Intelligence' had been treated as Control Variables. One group was treated as Experimental Group, taught through concept Attainment Model only, the second group was treated as Control Group, taught through Objective Based Instruction only.

The objectives formulated for the present investigation are given below.

3.2.1. To compare the mean scores of Achievement in Physics Post-Test I (tested immediately after the treatment) of the Control group and the Experimental group.

3.2.2. To compare the mean Gain scores of Achievement in Physics (Post-Test I minus Pre-Test) of the Control group and the Experimental group.

3.2.3. To compare the mean Retention scores of Achievement in Physics Post-Test II (tested two months after experimentation) of the Control group and Experimental group.

3.2.4. To compare the mean Gains cores of Achievement in Physics (Post-Test II minus Pre-Test) of the Control group and Experimental group.

3.2.5. To compare the mean scores of Achievement in Physics Post-Test I of the groups formed on the basis of Studying Approach.
3.2.6. To compare the mean Gain Scores of Achievement in Physics Post-Test I (Post-Test I – Pre-Test) of the groups formed on the basis of Studying Approach.

3.2.7. To compare the mean Retention scores of Achievement in Physics Post-Test II of the groups formed on the basis of Studying Approach.

3.2.8. To compare the mean Gain Scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test) of the groups formed on the basis of Studying Approach.

3.2.9. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for total sample, Boys and Girls.

3.2.10. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls.

3.2.11. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics
Post-Test I for Total sample, Boys and Girls when initial differences in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination.

3.2.12. To study the main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls when initial differences in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination.

3.3. HYPOTHESES

The hypotheses formulated and tested for the study are the following:

3.3.1. There will be significant difference in the mean scores of Achievement in Physics Post-Test I (tested immediately after the treatment) between Control group and Experimental group.

3.3.2. There will be significant difference in the mean Gain scores of Achievement in Physics (Post-Test I minus Pre-Test) between Control group and Experimental group.
3.3.3. There will be significant difference in the mean Retention scores of Achievement in Physics Post-Test II (tested two months after the treatment) between Control group and Experimental group.

3.3.4. There will be significant difference in the mean Gain scores of Achievement in Physics (Post-Test II minus Pre-Test) between Control group and Experimental group.

3.3.5. Students having Deep Approach to studying, Surface Approach to Studying and Strategic Approach to Studying will have significant difference in their mean scores of Achievement in Physics in Post-Test I.

3.3.6. Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying will have significant difference in their mean Gain Scores of Achievement in Physics Post-Test I (Post-Test I minus Pre-Test).

3.3.7. Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying will have significant difference in their mean Retention scores of Achievement in Physics Post-Test II.

3.3.8. Students having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying will have
significant difference in their mean Gain scores of Achievement in Physics Post-Test II (Post-Test II minus Pre-Test).

3.3.9. There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls.

3.3.10. There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test II for Total sample, Boys and Girls.

3.3.11. There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in Physics Post-Test I for Total sample, Boys and Girls when initial differences in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination.

3.3.12. There will be significant main effect and interaction effect of Methods of Teaching (Concept Attainment Model and Objective Based Instruction) and Studying Approach on Achievement in
Physics Post-Test II for Total sample, Boys and Girls when initial differences in select variables namely Previous Knowledge of Subject Matter and Non-Verbal Intelligence are controlled one by one and in combination.

3.4. PROCEDURE

The research design adopted for the study, procedure of selection of sample, conduct of experimentation, data collection procedure and techniques used for processing the data are described in this section.

3.4.1. The Research Design

The experimental design used in this study was Pre-Test – Post-Test Equivalent Groups Design. The design is illustrated as follows:

\[ \begin{align*}
G_1 & \quad O_1 \times O_2 \\
G_2 & \quad O_3 \quad C \quad O_4 \\
O_1, O_3 & \quad \text{Pre test} \\
O_2, O_4 & \quad \text{Post test} \\
O_2 - O_1 & \quad \text{Gain Score} \\
O_4 - O_3 & \\
G_1 & \quad \text{Experimental Group} \\
G_2 & \quad \text{Control Group}
\end{align*} \]
3.4.1.1. Sample of the Study

The population of the present study covers the secondary school students of Kerala. But the investigator decided to confine the study to students of standard IX since they can be considered as representatives of secondary school students. Care was taken to ensure that the subjects selected were equivalent in many respects. It was decided to select a co-educational school for the present study. It was also ensured that almost equal number of boys and girls were included in the sample. Instructional efficiency of the school was ascertained on the basis of the examination results of the previous years in the common Secondary School Leaving Certificate examination. For the smooth conduct of the experiment and for practical reasons it was decided to select a school from urban area. It was also ensured that the school is easily accessible and amenable for the conduct of the experiment. Based on these criteria, a school from the Palakkad district was selected for the present study. The school selected was N.S.S.K.P.T.H.S.S. Ottappalam.

Assuming that each class of the select school consists of approximately forty-five students, two English medium class divisions were selected. It was also decided to select the sample for the experiment
consisting of ninety students (forty-five students were treated as experimental group and forty-five students were treated as control group).

The actual number of sample in each group at the entry stage of the experiment is shown in the following breakup.

<table>
<thead>
<tr>
<th></th>
<th>Experimental Group</th>
<th>Control Group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>22</td>
<td>22</td>
<td>44</td>
</tr>
<tr>
<td>Girls</td>
<td>23</td>
<td>23</td>
<td>46</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>45</td>
<td>90</td>
</tr>
</tbody>
</table>

3.4.1.2. Allocation of Experimental Group and Control Group

It would be difficult to carry out an experimental study on a large sample. Since the random assignment to subjects in Experimental and Control groups will not be plausible in an organised set up of the schools and to get a more natural setting for the conduct of the study it was decided to select intact class groups. Two classes were therefore considered as the unit of study. The Experimental and Control groups were randomly selected by taking a lot.

3.4.1.3. Selection of the Topic for Treatment

The investigator carefully examined the syllabus and text books on Physics prescribed for the secondary schools of Kerala. It was felt that
topics which require mastery of basic essential concepts that have carry
over value, are worthwhile for experimentation. The investigator
consulted subject experts of Teacher Education Institutions, SCERT and
Physics teachers of secondary level for this purpose. A number of topics
from the basic units in the Physics syllabus of Secondary School Students
of Kerala State were found amenable for Concept Attainment Model of
Teaching and Objective Based Instruction. It had been pointed out that
nine basic subunits in the secondary school Physics text books of Kerala
syllabus are having maximum application in day-to-day life and linkage
with other subjects. These sub units are listed below:

(i) Light
(ii) Force
(iii) Gravitation
(iv) Motion
(v) Work and Energy
(vi) Fluids
(vii) Sound
(viii) Magnetism and Electricity
(ix) Heat

The investigator could identify a number of topics from these basic
subunits amenable for Concept Attainment Model of Teaching and
Objective Based Instruction. Due to constrain in time thirty topics were altogether selected finally for the present study. Details of the selected topics are given in the following break-up.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Topic selected</th>
<th>Basic Sub unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Scattering of light</td>
<td>Light</td>
</tr>
<tr>
<td>2.</td>
<td>Dispersion of light</td>
<td>Force</td>
</tr>
<tr>
<td>3.</td>
<td>Fluorescence</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Force</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Momentum</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Inertia of rest and Inertia of motion</td>
<td>Gravitation</td>
</tr>
<tr>
<td>7.</td>
<td>Action and Reaction</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Impulsive force and Impulse</td>
<td>Motion</td>
</tr>
<tr>
<td>10.</td>
<td>Gravitational force</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Acceleration due to gravity</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Mass and weight</td>
<td>Fluids</td>
</tr>
<tr>
<td>13.</td>
<td>Uniform Circular Motion</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Centripetal force and Centrifugal force</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Work and Energy</td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Viscosity</td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Surface Tension</td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>Cohesion and Adhesion</td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>Capillarity</td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>Density and relative density</td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>Transverse wave and Longitudinal wave</td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>Sound</td>
<td></td>
</tr>
<tr>
<td>24.</td>
<td>Sources of Sound</td>
<td></td>
</tr>
<tr>
<td>25.</td>
<td>Resonance</td>
<td></td>
</tr>
<tr>
<td>26.</td>
<td>Electrostatic force and Magnetic force</td>
<td>Magnetism and Electricity</td>
</tr>
<tr>
<td>27.</td>
<td>Magnetic Induction</td>
<td></td>
</tr>
<tr>
<td>28.</td>
<td>Conductors and Insulators</td>
<td></td>
</tr>
<tr>
<td>29.</td>
<td>Change of state and latent heat</td>
<td>Heat</td>
</tr>
<tr>
<td>30.</td>
<td>Evaporation</td>
<td></td>
</tr>
</tbody>
</table>
3.4.1.4. Preparation of Instructional Materials

The investigator prepared separate instructional materials for Experimental and Control Groups for topics selected for treatment.

3.4.1.4.1. Lesson Transcripts for Concept Attainment Model

A. Planning of lesson formats

The investigator prepared lesson transcripts for Concept Attainment Model as per the suggestions of Joyce and Weil (1992). Thirty lesson transcripts for Concept Attainment Model have been prepared for thirty periods each of forty-five minutes duration. The topic selected and the specific objectives set for each learning unit is the same for the Experimental and Control Treatments. In each Lesson Transcript there are three consecutive phases.

Phase One: Presentation of Data and Identification of Concept

Labelled examples will be presented to the students. Students will compare attributes in positive and negative examples and will generate and test hypotheses. Finally they will arrive at a definition of the concept according to the essential attributes.

Phase two: Testing Attainment of the Concept

Here students are supposed to identify additional unlabelled examples as 'Yes' or 'No'. Teacher will confirm hypotheses, name concept
and will restate definitions according to essential attributes. Finally students will generate examples.

**Phase three: Analysis of Thinking Strategies**

Here students will describe their thought process in analysing the examples and non examples. They will discuss the role of hypotheses and attributes. They will discuss the type and number of hypotheses.

**B. Try out**

Three lesson plans were prepared initially for try out. It was decided to try out the lesson plans to ensure the time required for the completion of teaching that topic covering all the phases of teaching. The difficulties faced while implementing this method in the usual classroom set-up was noted. The concerned Physics teacher for that class and an expert in the field of Physics education were also present as observers throughout the classes during try out. Based on the reactions and responses by the students and the opinions of teachers observations were noticed. The lesson formats were further scrutinised and revised by the investigator based on the suggestions and observations. Slight modifications were made on the lesson plans. These lesson plans were again scrutinised by experts in Physics and the supervising teacher. Thus lesson plans for Concept Attainment Model were finalised. Two lesson
plans based on Concept Attainment Model together with the format for observation lesson is presented as Appendix IA, IB and IC respectively.

3.4.1.4.2. Lesson Transcripts for Objective Based Instruction

For Control group thirty lesson plans were prepared on the basis of Instructional Objectives of Bloom's Taxonomy adopted by NCERT. For this purpose the content was thoroughly analysed on the basis of the objectives that are to be attained in the cognitive domain. These objectives were again analysed into observable and measurable behavioural changes (specifications) that are to be taken place in the learner. These specifications acted as the basis for planning lessons for control group. The terminal behaviours were then identified and written as instructional objectives. Based on the blue print of the lesson format, lessons were prepared.

The format of Objective Based Instruction is given below.

**Preparation**

- Reviewing the previous knowledge.
- Motivating the learner to learn the new ideas.
- Why he/she is going to learn these ideas.
Presentation

- Presenting the new materials.
- Providing provisions for students for activity.
- Active participation of students.
- Evaluation at appropriate time.

Application

- Applying the newly learned content or skill in different situation.

Reviewing and Assignments

- Reviewing newly learned materials.
- Drill work and home assignments.

Two sample lesson plans are given as Appendix IIA and IIB.

3.4.1.5. Studying Approach Inventory

A Studying Approach Inventory was prepared and standardised by the investigator.

3.4.1.5.1. Construction and Standardisation of Studying Approach Inventory

Research work on Studying Approach identified a number of different Studying Approaches employed by students. Two studying approaches – deep approach and surface approach – was identified by
Marton and Saljo (1976) and Svensson (1977). Deep approach is based on intrinsic motivation, learning with an aim to understand the material presented. Surface approach is based on extrinsic motivation, learning as rote memorization and an aim to achieve only course requirements. Some research studies described another approach to learning related to the competitive form of motivation. This approach was described as Achieving by Biggs (1979) and Strategic Approach by Ramsden (1981). Strategic Approach involves an intention to obtain highest possible marks by strategic management of time and efforts. According to Valet and Chalmere (1992) it refers to shifts between Deep and Surface Approaches.

Measuring student's studying approach has been seen as a means of observing the outcomes (Biggs and Collins, 1982) and experience of learning (Marton et al., 1984) and for evaluating the quality of student learning (Meyer and Muller, 1990). A number of tools for assessing Studying Approach have been developed by various researchers.

For constructing this tool, the investigator analysed a number of important Studying Approach Inventories like ASI, RASI, LASSI, ETLQ, LSQ and the like. After a thorough analysis of theoretical constructs three approaches were selected for the study. The selected studying approaches are given below: (i) the deep approach (ii) the surface approach (iii) the strategic approach.
After a thorough analysis and consultation with experts, a number of items were pooled under each studying approach sub-scale. The core components of each category of studying approaches and corresponding activities were analysed thoroughly and the items in the inventory were prepared in accordance. The inventory was distributed to subject experts and their suggestions were taken into account. Incorporating all the necessary factors, and after thorough scrutiny 58 items were finally taken for the draft version of the Studying Approach Inventory. Out of these 58 items 20 items comes under deep approach subscale, 18 items under surface approach subscale and 20 items under strategic approach subscale.

The detailed description of the studying approach inventory is given in the following sections.

The Deep Approach Sub Scale

The core aspect of a fully developed deep approach is the intention to form a personal understanding of the topic under study. This is then combined with a range of conceptually related learning processes. The elements of the Deep Approach to Studying are listed below:

(i) Intention to understand.
(ii) Active interest and personal engagement
(iii) Relating ideas
(iv) Gaining an overview
(v) Creating outlines and structures
(vi) Questioning and using evidence critically.
(vii) Seeking the central point
(viii) Drawing conclusions
(ix) Seeking the purpose of a task or seeing it in its wider context.

These elements can be categorised into four basic categories as follows:

(i) Seeking meaning
(ii) Relating and organizing ideas
(iii) Using evidence and logic
(iv) Interest in ideas.

The twenty items that make up the deep approach sub scale of the studying approach inventory relate to the above four categories. The illustrative items under each category are given in the following break-up.
The Surface Approach Sub-scale

The surface approach refers to a type of ineffective studying method. The major factor identified with surface approach is 'lack of purpose'. It is also called 'surface apathetic'. This approach brings together syllabus boundedness and lack of understanding with both lack of purpose and fear of failure. The elements of the surface approach to studying are listed below.

(i) memorising without understanding.
(ii) unreflective studying
(iii) fragmented knowledge
(iv) unthinking acceptance
(v) lack of purpose

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Item No.</th>
<th>Item Statement</th>
<th>Basic element</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>While studying, I try to find out for myself the meaning of the prescribed lessons.</td>
<td>Seeking meaning</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>I try to relate the learning materials with other topics studied</td>
<td>Relating and organising ideas</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>I like to analyse the reason behind things</td>
<td>Using evidence and logic</td>
</tr>
<tr>
<td>4</td>
<td>29</td>
<td>While reading a text book I think a lot about ideas presented in them</td>
<td>Interest in ideas</td>
</tr>
</tbody>
</table>
(vi) syllabus boundedness

(vii) fear of failure.

These elements can be categorised into four basic categories as follows:

(i) Lack of purpose.
(ii) Unrelated memorising.
(iii) Syllabus boundedness
(iv) Fear of failure

The eighteen items that make up the surface approach subscale of the studying approach inventory relate to relying on memorisation, difficulty in making sense, unrelatedness and concern about coping. The illustrative items under each category are given in the following break-up.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Item No.</th>
<th>Item Statement</th>
<th>Basic element</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>37</td>
<td>I wonder what prompted me to go to school</td>
<td>Lack of purpose</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>While studying I can easily remember bits and pieces but cannot present it as a whole concept</td>
<td>Unrelated memorising</td>
</tr>
<tr>
<td>3</td>
<td>23</td>
<td>I like teachers to give guidelines while assigning the projects or duties</td>
<td>Syllabus boundedness</td>
</tr>
<tr>
<td>4</td>
<td>52</td>
<td>I am anxious whether I will be able to attain the expected standard while doing the assigned work</td>
<td>Fear of failure</td>
</tr>
</tbody>
</table>
The Strategic Approach Subscale

The strategic approach to studying include an aspect of meta cognition and self regulation – monitoring effectiveness. Achievement motivation is strongly associated with the organized studying and time management. Determination to excel and alertness to assessment demands are the basic characteristics of strategic approach. Elements of Strategic Approach to Studying are listed below:

(i) Monitoring study effectiveness
(ii) Monitoring understanding
(iii) Monitoring generic skills
(iv) Study organisation
(v) Time management
(vi) Effort management
(vii) Achievement Motivation
(viii) Alertness to assessment demands.

These elements can be categorised into five basic categories as follows:

(i) Organised studying
(ii) Time management
(iii) Alertness to Assessment demands
(iv) Achievement motivation

(v) Monitoring effectiveness

The twenty items that make-up the Strategic Approach subscale of the Studying Approach Inventory relate to the above five basic categories. The illustrative items under each category are given in the following break-up.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Item No.</th>
<th>Item Statement</th>
<th>Basic element</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>42</td>
<td>I am in the habit of planning my work in advance</td>
<td>Organized studying</td>
</tr>
<tr>
<td>2</td>
<td>25</td>
<td>I follow a time table while revising for examinations</td>
<td>Time management</td>
</tr>
<tr>
<td>3</td>
<td>28</td>
<td>While writing an assignment, I try to incorporate the viewpoints of the teacher who is going to value it</td>
<td>Alertness to assessment demands</td>
</tr>
<tr>
<td>4</td>
<td>34</td>
<td>I study really hard because I am determined to do well.</td>
<td>Achievement motivation</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>I am in the habit of going over my work again and again to find out whether there are any mistakes.</td>
<td>Monitoring Effectiveness.</td>
</tr>
</tbody>
</table>

3.4.1.5.2. Administration and Scoring

The draft version of Studying Approach Inventory was administered on a stratified sample of four hundred students. A separate response sheet was given for answering. A covering letter with
instructions for answering the items were given along with it. The inventory was prepared on a three point scale 'Agree', 'Disagree' and 'Not sure' with scores 2, 1, 0 respectively. The draft version of Studying Approach Inventory and the Response Sheets are given in Appendix IIIA and IIIB respectively.

3.4.1.5.3. Item Analysis

From the 400 response sheets, incomplete sheets were discarded and by random rejection some more sheets were discarded to get the final number of response sheets as 370. The total score of each respondent was calculated for conducting item analysis. The procedure suggested by Edwards (1957) was used to find out the discriminating power of items. The scored answer sheets are arranged in ascending order and top 100 students (27 percent) and bottom 100 students (27 percent) were taken as the high group and low group respectively. Then the 't' value of 58 items were calculated and tabulated. Items which have 't' value of 2.58 and above were selected with an inference that such item discriminate between high group and low group students. The item analysis details are given as Appendix IIIC.

Six items were omitted after item analysis and the remaining 52 items were selected. Thus the final version of the Studying Approach
Inventory have 52 items. The final version of the Studying Approach Inventory is given as Appendix IIW.

The number of selected items falling under each approach and break up of the number of questions are as follows:

**Break up of Number of Questions of Deep Approach**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Basic Elements</th>
<th>Question No.</th>
<th>No. of Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Seeking meaning</td>
<td>1, 31, 44, 45</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Relating and organising ideas</td>
<td>29, 30, 46, 48, 49, 50</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Using evidence and logic</td>
<td>2, 4, 11, 27, 38, 47</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Interest in Ideas</td>
<td>5, 13, 22, 36</td>
<td>4</td>
</tr>
</tbody>
</table>

**Break up of Number of Questions of Surface Approach**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Basic Elements</th>
<th>Question No.</th>
<th>No. of Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lack of purpose</td>
<td>37, 58</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Unrelated memorising</td>
<td>6, 12, 17, 19, 24, 33</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Syllabus boundedness</td>
<td>23, 35</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Fear of failure</td>
<td>52, 55</td>
<td>2</td>
</tr>
</tbody>
</table>
Break up of Number of Questions of Strategic Approach

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Basic Elements</th>
<th>Question No.</th>
<th>No. of Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Organised studying</td>
<td>9, 10, 21, 42, 57</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Time management</td>
<td>25, 32, 41, 56</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Alertness to assessment demands</td>
<td>14, 28, 39</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Achievement motivation</td>
<td>20, 26</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Monitoring Effectiveness</td>
<td>15, 34, 40, 43, 53, 54</td>
<td>6</td>
</tr>
</tbody>
</table>

3.4.1.5.4. Validity of Studying Approach Inventory

The Studying Approach Inventory was prepared after studying all the theoretical construct of the variable Studying Approach in depth. The core components of each category of Studying Approaches and their corresponding activities were analysed thoroughly and the items of the inventory were prepared in accordance. Thus the content validity was established.

Criterion validity was established by correlating the scores on Studying Approach inventory obtained by forty students of class IX with their scores obtained on Science Studying Approach Inventory developed by Pillai et al. (1992). Pearson's product moment coefficient of correlation was used for this purpose. The correlation coefficient was found to be 0.68.
The inventory was distributed to subject experts and their suggestions were taken into account. Hence the tool ensures high face validity.

3.4.1.5.5. Reliability of Studying Approach Inventory

Cronbach Alpha method was used to find out the reliability. The coefficient was found to be 0.92 which indicates a very high reliability. Gutman's split half method was also used to establish the reliability. The reliability coefficient obtained was found to be 0.88.

3.4.1.6. Standard Progressive Matrices Test (Raven, 1958)

Non-Verbal Intelligence of the subjects were measured by administering the standard form of the Raven's Progressive Matrices test. This non-verbal test, developed by Raven (1958) was used to estimate the subjects' ability to discern and utilize a logical relationship presented by non-verbal materials. The test consists of five subsets of twelve items each. In each item a part of the geometrical design is missing. Six or eight alternatives are given for each design. All of those fit the missing part, but only one logically belongs to it. The test is a popular measure of the 'g' factor of Intelligence.

Validity of the test has been estimated in a variety of usual ways. When Stanford-Binet Test was used as the criterion, correlation
coefficient varied from 0.5 to 0.86. The reliability coefficient of the test vary from 0.80 to 0.90 as reported by Raven. In a study conducted by Nair (1972) in Kerala, the reliability coefficient was found to vary from 0.70 to 0.86 by split-half method and from 0.84 to 0.91 by test-retest method.

Response sheet of Raven's Progressive Matrices Test is given as Appendix IV.

3.4.1.7. Achievement Test in Physics

An Achievement Test in Physics developed by the investigator was used as the pre-test. The same test was used as the post-test also. Steps in the construction of the test are described in the following sections.

(i) Planning of the Test

The curriculum, syllabus and text books of Physics for secondary classes have been thoroughly studied by the investigator for preparing the achievement test in Physics. The investigator also consulted with subject experts and experienced teachers in Physics for guidance. The books referred for preparing the test are given below.

(i) G.C.S.E. Science Double Award Physics (Foulds, 1996).
(ii) Nuffield Physics (Dorling, 1988).


The test consists of objective type items only. The duration of the test has been fixed for two hours. The test was intended to measure abilities of cognitive domain only. In order to achieve maximum objectivity, only multiple choice items were included in the test. The maximum marks fixed for the test was 75.

(ii) Preparation of the Test

Items for the Achievement Test in Physics were prepared on the basis of the major objectives in the cognitive domain namely Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation.

In the preparation of the test, due weightage was given to the objectives and content. Weightage to level of difficulty was considered while selecting the items.

(iii) Preparation of Blue Print

A blue print ensuring weightage to objectives and content was prepared. The form of questions was already fixed as to include only the multiple choice items.
A two-way grid specifying weightage to objective and content was prepared as a blue print for the final test and is given in Table 3.1.
(iv) Item Writing

Based on the design of the test the investigator pooled initially 100 multiple choice items to be included in the draft test so as to get enough number of items of proved psychometric properties in the final test. For each item four answers were given of which only one is the correct answer and other three are distractors. The items were scrutinised by experienced physics teachers and teacher educators. On the basis of their suggestions, some items were omitted and some were modified. After editing, the
number of items for the draft test was 75. Necessary instructions for responding to the items were also prepared.

(v) Pilot Testing

The draft test consisting of 75 items with general instructions and specific instructions for answering the questions was administered to 25 students of standard IX. Oral instructions were also given besides the written instruction whenever necessary to clear doubts. Time taken for completion of test by each student was also noted. Scoring was done on the basis of already prepared scoring key. By observing students taking test and analysing the problems faced by students who took the test, slight changes were made in the instructions.

Illustrations of items under each objective is given below.

Knowledge Category

Qn. No. 2 The property of a body by which it continues in its state of rest is:

A. Momentum
B. Inertia of rest
C. Inertia of motion
D. Weight
Comprehension Category

Qn. No. 70. 'Action and Reactions are equal and opposite'.

Considering the above statement which of the following are correct?

A. They cancel each other because they are equal and opposite.
B. They do not cancel each other because they are equal and opposite.
C. They cancel each other because they are acting on the same object.
D. They do not cancel each other because they are acting on different objects.

Application Category

Qn. No. 58. When a person gets electric shock, his heart tends to stop.

This is because:

A. He is having tension.
B. Viscosity of blood increases.
C. Viscosity of blood decreases.
D. Pressure of blood decreases.
Analysis Category

Qn. No. 47. In an experiment, a scientist placed an object at the equator and found its weight. Then he placed it at the poles and found its weight. From the data he found the weight of the object when it is placed at the centre of the earth. He concluded that the object had different weights in the three instances.

Which of the following assumptions is implicit in this experiment?

A. The weight of the object is negligible at the centre of the earth.

B. Acceleration due to gravity is the same at all places on the earth's surface.

C. Acceleration due to gravity is different at different places.

D. Weight is not determined by acceleration due to gravity.

Synthesis Category

Qn. No. 52. You are to conduct an experiment to determine whether the rate of evaporation of a liquid is affected by an increase in
the amount of heat given. You have the relevant apparatus to conduct the experiment.

If the increase in the amount of heat have an observable effect on the rate of evaporation in liquids, almost immediately after increasing the amount of heat you would expect to observe a notable change in the:

A. temperature of liquid molecules.
B. motion of liquid molecules.
C. amount of liquid vapour over the liquid surface.
D. pressure of the liquid.

Evaluation Category

Qn.No. 35. A book is placed on a table. It was observed that the book rotates when the table is rotated. In this experiment centripetal force for rotation of the book is given by frictional force between the book and the table. The book was found to be thrown away when the speed of rotation of the table was increased.

Which of the following conclusions can be justified based on the above experiment?

A. The book rotates slowly when the table is rotated faster.
B. The book rotates faster when the table is rotated slowly.

C. The book was thrown away because the centripetal force was balanced by friction.

D. The book was thrown away because beyond a speed limit centripetal force cannot be balanced by friction.

(vi) Try-out of the Draft Test

The draft test consisting of 75 items were administered to a sample of 400 students of standard IX. Before administering the test the investigator approached the administrators and students to make clear the purpose of the test. The test together with response sheet was given to subjects. General guidelines were given before the test started. Specific guidelines and additional information were given whenever necessary.

The response sheets were collected and scored using the already prepared scoring key. One score was given for the correct answer and no score was given to wrong answers.

(vii) Item Analysis

Item analysis was undertaken using the method suggested by Ebel and Frisbie (1991). 370 response sheets complete in all respects were taken for item analysis. Incomplete sheets and manipulated sheets were
discarded. For the analysis the response sheets were arranged in the descending order of total marks obtained by the subjects. The top 100 students (27 percent) and bottom 100 students (27 percent) were taken as the high group and low group respectively. The response for each item by the two groups was noticed. The index of difficulty and discriminating power of each item were computed using the formula suggested by Ebel and Frisbie (1991).

\[
\text{Difficulty Index of item, } D_i = \frac{U + L}{2N}
\]

\[
\text{Discriminating power of item } D_p = \frac{U - L}{N}
\]

where,

\( U \) = Number of right responses in the upper group.

\( L \) = Number of right responses in the lower group.

\( N \) = Number of subjects in any of the group.

The difficulty index and discriminating power of each item was calculated.

Difficulty index ranging between 0.30 and 0.80 with discriminating power above 0.30 were readily selected for the final test. Thus final test with 60 items was prepared with necessary instructions to respond. This test was then put to test for validity and reliability.
Draft Achievement Test in Physics, Scoring Key, Response Sheet, Details of Item Analysis and Final version of Achievement Test in Physics are given as Appendices VA, VB, VC, VD and VE respectively.

(viii) Validity

The validity of the Achievement Test in Physics was established in two different ways.

Subjecting the test items for experts criticism, content validity of the test was ensured. As per the evaluation of experts, the test content agrees with the treatment content in both the dimensions objective basedness and comprehensiveness.

Criterion validity was established by correlating the scores on Achievement test in Physics obtained by 40 students of standard IX with their marks obtained in Physics in the previous terminal examination. Pearson's product moment formula was used for this purpose. The correlation coefficient was found to be 0.70.

(ix) Reliability

The split half reliability was established by correlating the odd and even sets of scores and the obtained value is 0.84.
The indices of validity and reliability indicated that the Achievement test in Physics has acceptable psychometric properties to measure the Achievement in Physics of standard IX students.

3.4.1.8. Data Collection Procedure

After finalising the selection of the school for the present investigation, the head of the school was contacted through proper channel for getting permission for conducting the experiment. The investigator appraised the principal of the school regarding the importance of the study and a schedule was fixed for experimentation. The experimentation commenced in the month of July and completed in October, 2005.

3.4.1.8.1. Administration of Pre-test

Prior to the introduction of treatment in the selected school, data on previous knowledge of subject matter directly linked with the experiment, Non-Verbal Intelligence, and Studying Approaches of the subjects were collected. For this purpose Achievement Test in Physics (Pre-Test), Ravens Progressive Matrices Test and Studying Approach Inventory were administered. The procedure suggested in the manual for the administration was followed especially for Ravens Progressive Matrices Test. The data thus collected ensured the entry status of the
students in terms of Achievement in Physics, Non-Verbal Intelligence and Studying Approach.

3.4.1.8.2. Procedure of Treatment

The Experimental and Control group were given different treatments. The control group was taught through Objective Based Instruction and the Experimental group was taught through Concept Attainment Model of Teaching.

3.4.1.8.2.1. Control Group

The treatment procedure in the control group is described below.

Students of standard IX A1 division of N.S.S.K.P.T.H.S.S. formed the control group. Without altering the organisational set up of the classroom the investigator herself taught the lessons through Objective Based Instruction (OBI). Only conventional teaching aids were used during the treatment. Thirty lessons were taught. No formative/unit test was administered during the treatment.

(i) Introduction

For each class the first seven minutes was spent for the introduction stage. During this stage the previous lesson was reviewed and also few introductory questions relevant to the new lesson were asked to motivate
the students and create interest in the class. Thus a favourable situation was created for learning.

(ii) Development

The second stage was the development stage. At this phase the investigator tried to develop the new concepts in an expository manner. It was done mostly through pupil activity or through illustrative talk. Though there were pupil activities they were mostly teacher directed and uniform for all students. Appropriate blackboard work was given by the teacher as visual supplement or summary of the lesson. Proper generalisation and discrimination were done through several examples.

In this group, students were mostly passive observers and there was more teacher activity. Occasionally mass answering was aloud. Students did not get enough opportunity to participate actively in the learning process. About fifteen minutes was spent for this stage.

(iii) Application

The third stage is application stage. Here the subjects applied the newly learned concepts in new and day-to-day situations. At first it was done with the help of the teacher and then subjects were allowed to do it by themselves.
(iv) Review and Recitation

This was the last stage. About eight minutes was spent for this stage. Teacher-directed evaluation was done during this stage. Class assignments and procedure for home assignments were also given.

Thirty lessons were taken in thirty periods. No remedial teaching was attempted during treatment. But doubts were cleared during review stage.

3.4.1.8.2. Experimental Group

Students of standard IX A2 division of NSSKPTHSS formed the experimental group. Thirty lesson plans based on Concept Attainment Model were already prepared for Experimental group.

The procedure of treatment given to Experimental group is described below.

(i) Presentation of data and identification of concept

This is the first phase of the Concept Attainment Model. The classes were started with an orientation to the students by the investigator to motivate the students. Then the investigator presented labelled examples. Students were allowed to compare the attributes in positive and negative examples. Finally the students were able to state a definition of the concept according to the essential attributes. This was mostly done
with the help of the teacher and with proper directions. The investigator provided cues and prompts wherever necessary.

(ii) Testing Attainment of the Concept

This is the second phase of the Concept Attainment Model. The teacher presented unlabelled examples during this phase. The students identified these unlabelled examples as 'Yes' or 'No'. The teacher analysed and modified and confirmed the hypotheses formed by the students. Then the teacher named the concepts and restated the definition of the concept according to essential attributes. Finally the students were allowed to generate examples. Active student participation was ensured during this period.

(iii) Analysis of Thinking Strategies

This is the last phase of Concept Attainment Model. It is like the review session in OBI. Here the students were allowed to describe their thoughts while formulating hypotheses. Subjects discussed the role of hypothesis and attributes. Subjects discussed the type and number of hypotheses formed. Here an opportunity was given to each subject to analyse their thought process. If students were not accurate, they went through a correction procedure with the help of the investigator.
The positive and negative examples were carefully prepared by the investigator well in advance. They were labelled and arranged in such a way that the attributes were clear. Additional examples were provided wherever needed. The investigator acted as a recorder. Points and cues were provided wherever necessary. The social system of the classroom was highly structured. It can be noted that the learning environment of the classroom was learner centred and not authoritarian. The teacher provided appropriate instructions and guidance during the activities carried by the learners.

Principles of Reaction

The investigator supported the discussions by the subjects but at the same time emphasized the hypothetical nature of discussion. The students were helped to balance one hypothesis against another and to focus attention on specific features of examples. They were assisted in discussing and evaluating their thinking strategies. This ensured the principles of reaction inherent in Concept Attainment Model.

Support System

The sequential and logical arrangement of the learning tasks, carefully selected and organized materials and data in the form of discrete
units to serve as examples, meaningful learning experiences, scripted
lesson plans and motivation from teacher acted as the support system of
Concept Attainment Model.

**Instructional Effect**

The highly structured instructional approach accelerated the
learning. Students were able to get clear notions about nature of concepts.
Subjects developed skills in using appropriate concept building strategies
and attained the specific concepts. The most important instructional effect
is that it helped in developing the skill of inductive reasoning among
subjects.

**3.4.1.8.3. Administration of Post-Test I**

To quantify the terminal characteristics of the subjects in terms of
Achievement in Physics the investigator administered a Post-Test. The
post-test data from the subjects in the Control group and Experimental
group were gathered the next day after the completion of the treatments.
The test was conducted simultaneously for the Experimental and Control
groups inorder to ensure objectivity by the test. All necessary guidelines
and purpose of the test were explained to the subjects in each group.
3.4.1.8.4. Administration of Post-Test II

Two months after the treatment the investigator administered the Post-Test once again to Control group and Experimental group. The aim of this test was to explore the extent of retention of Achievement in Physics of standard IX students.

3.4.2. Scoring and Consolidation of Data

The response sheets were scored according to the already prepared scoring key. The investigator strictly followed the specific directions given in the manual for Raven's Progressive Matrices Test. Incomplete score sheets and data obtained from students who had not regularly attended the experimental class sessions were not included for the analysis. Cases, which were complete in all respects were taken into consideration. The break up of the actual number of subjects falling under different category is given in Table 3.2.

<table>
<thead>
<tr>
<th>Name of Group</th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group</td>
<td>20</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>Control Group</td>
<td>20</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>40</td>
<td>80</td>
</tr>
</tbody>
</table>

TABLE 3.2
The Final Break-up of Subjects Falling Under Different Categories
3.4.3. Procedure Used for Analysis of Data

The hypotheses of the present study were tested by employing appropriate statistical techniques. The entire statistical processing was done using computer facility.

Statistical techniques employed in the study are given below:

A. Test of Significance of Difference between Means of Large and Small Independent Samples

To test the first five hypotheses the test of significance of difference between means of large and small independent sample were used. Control group and Experimental group were compared with respect to their mean Post-Test I, Post-Test II and Gain scores for Total sample, Boys and Girls. Pupils having Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying were also compared with respect to their mean Post-Test I, Post-Test II and Gain scores.

The difference between means was tested using two-tailed test of significance and the results were interpreted using appropriate degrees of freedom.
The present experiment was conducted with intact classroom groups for practical reasons. Therefore in order to ensure the equivalence of the groups before the treatment, variables were introduced. The variables selected for determining the equivalence of the groups were 'Previous Knowledge of the Subject Matter' and 'Non-Verbal Intelligence'. Analysis of Covariance was used to equate the pre-experimental status of the treatment groups in terms of 'Previous Knowledge of the Subject Matter' and 'Non-Verbal Intelligence'. The assumption implicit in the meaningful use of Analysis of Covariance is that a direct causal relation exist between the co-variates and the dependent variable (Ferguson, 1981). In order to find out the nature of the relationship between the Control Variables and Achievement in Physics (Post-Test I and Post-Test II), correlation analysis was used.

Correlation is the relationship between two or more paired variables or two or more sets of data. The degree of relationship is measured and represented by the co-efficient of correlation. The most often used and most precise coefficient of correlation is the Pearson Product Moment Correlation denoted by the symbol 'r'. Pearson Product Moment Correlation was used to find out the degree of relationship
between the Control Variables and the Achievement in Physics (Post-Test I & II).

Verbal Interpretation of 'r' was done according to the method provided by Garret (1981). The coefficient of correlation between two variables is described as 'high', 'marked' or 'substantial', 'low' or 'negligible' depending upon the numerical index of 'r'. The interpretation is as shown below.

(i) 'r' from .00 to ± 0.20 - denotes indifferent or negligible relationship.
(ii) 'r' from 0.20 to ± 0.40 - denotes low or slight relationship.
(iii) 'r' from 0.40 to ± 0.70 - denotes substantial or marked relationship.
(iv) 'r' from 0.70 to ± 1.00 - denotes high to very high relationship.

C. Two-way Analysis of Variance (ANOVA) with 2x3 Factorial Design

To study the main effect and interaction effect of Methods of teaching (Concept Attainment Model of teaching and Objective Based Instruction) and Study Approaches (deep, surface and strategic) on Achievement in Physics, Two way Analysis of Variance with 2x3 factorial design was employed. By this method one can study the single effect of each of the Independent variable on the Dependent variables and interaction effect of the Independent variables on the Dependent variable. Interpretation of the analysis was done on the basis of F-values – whether
F-ratio is significant or not at 0.01 level or 0.05 level for appropriate degrees of freedom.

D. Scheffé Test for Multiple Comparison

Scheffé Test for Multiple Comparison (Ferguson, 1981) was applied to compare the relevant category of the independent variables (when more than two categories are made) in relation to the mean scores of Achievement in Physics Post-Test I and Achievement in Physics Post-Test II.

E. Analysis of Covariance (ANCOVA)

In the present study, Two factor ANCOVA employing two co-variates (singly and in combination) was used to confirm the effectiveness of Concept Attainment Model of Teaching over Objective Based Instruction. Through Analysis of Covariance one can control or adjust the effects of one or more uncontrolled variables and thereby permit a valued evaluation of the outcome of experiment. It is applied when there are one or more correlated variables existing with the Dependent Variable. In the present study the co-variates are Previous Knowledge of the Subject Matter and Non-Verbal Intelligence. ANCOVA was used to remove statistically the effects of Previous Knowledge of Subject Matter and Non-Verbal Intelligence separately and in combination.