Chapter-IV

DESIGN OF
THE STUDY
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4.1 INTRODUCTION

Theoretical aspects considered in the first chapter led to the formulation of hypotheses. The second chapter deals with the information about the models of teaching and detailed about the Concept Attainment Model and Inductive Thinking Model of teaching, which are selected for the present study. Empirical evidences are presented in the third chapter. The fourth chapter describes the research design that was planned and executed to test the hypotheses.

The research design defined by Kerlinger (1973, P. 300) is as under -

"Research design is a plan, structure and strategy of investigation conceived so as to obtain answers to research questions and controlled variance". The plan includes an outline of what the researcher will do from writing the hypotheses to the final analysis of the data. The structure refers to scheme of the operation of variables. The strategy implies how the research objectives will be reached. By constructing an efficient research design the investigator attempts:

1. To maximize the variance of the variables of her substantive research hypotheses.

2. To control the variance of extraneous variables that may have effect on experimental outcomes.

3. To minimize the errors variance.
4.2 METHOD OF THE STUDY

Methods of research in education are broad distinguishing features of different researches. Research studies distinguished on the basis of their different purposes (approaches) and that is what may technically be called difference in methods. Actually the study adopting different methods do not differ in their procedure, approach data collection, interpretation of data reporting of the work done etc. But for the convenience they may be classified in three types:

1. The Historical Research Method
2. The Normative Survey or Descriptive Research Method
3. The Experimental Research Method

The selection of research method depends upon the nature of the problem selected and kind of the data necessary for its solution. Method selected should be appropriate to the problem under investigation, feasible, pre-planned and well understood.

For the investigation of the present problem, the Experimental Research Method was chosen. Selection of the experimental design is based on the purpose of the experiment, the type of variable to be manipulated and the conditions or limiting factor under which it is conducted.

The design deals with such practical problems as how subjects are to be selected for experimental and control groups, the way variables are to be manipulated and controlled, the way extraneous variables are to be controlled, how observations are to be made and the type of statistical analysis to be employed in interpreting data relationships.

Quasi-Experimental method was employed for the present study with parallel group design (Campbell and Stanley, 1963, P.127) with non-equivalent purposive sample. The pre-test-post-test nonequivalent group design is diagrammatically presented as in Fig 4.1
Fig-4.1
Diagramatic Representation of Non equivalent-Group Design

\[
\begin{array}{ccc}
O_1 & X_1 & O_2 \\
\hline
O_3 & X_2 & O_4 \\
\hline
O_5 & C & O_6 \\
\end{array}
\]

This design is often used in classroom experiments when experimental and control groups are such naturally assembled groups as intact classes, which may be similar. The difference between the mean of the \( O_1 \) and \( O_2 \) scores, the difference between the mean of the \( O_3 \) and \( O_4 \) scores and the difference between the mean of the \( O_5 \) and \( O_6 \) scores are tested for statistical significance. Since this design may be the only feasible one, the comparison is justifiable, but the result should be interpreted cautiously.

This chapter deals with the methodology used, research design, variables, tools of the data collection used, procedure, precautions, constraints and the like, under following heads.

i. Variables

ii. Sample

iii. Tools

iv. Procedure

v. Precautions observed

vi. Constraints and difficulties
4.3 EXPERIMENTAL VARIABLES

The variables are the conditions that the experimenter manipulates, controls and observations during the course of the treatment. Different kinds of variables used in the study as under-

4.3.1 Independent Variables

As the impact of models of criterion variables had to be studied, the method of instruction or teaching strategy in the form of models of teaching (Concept Attainment Model and Inductive Thinking Model) and Traditional Method of teaching were used as treatment variables. The independent variables used in the study were Concept Attainment Model, Inductive Thinking Model and Traditional Method of teaching. These three variables are manipulated to study the effectiveness.

4.3.2 Dependent Variables

The dependent variables or the criterion of the study were the Reasoning Ability, Scientific Creativity, Attitude Towards Science and students' Achievement in Science. The students were scored on these variables before and after the treatment in all the three groups.

4.3.3 Covariate

To eliminate the initial variability of the students statistically in all the three groups, they were measured on scores of students' Achievement in VIII class Science. Achievement in Science is an index of intelligence, which might have affected the criterion variable.

The controls employed in this experiment were as given below in Table 4.1.
Table 4.1
Controls Employed

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Variables</th>
<th>Controls Employed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grade</td>
<td>Same grade class - IX</td>
</tr>
<tr>
<td>2</td>
<td>Age</td>
<td>Same age group with average age of 14 - 16</td>
</tr>
<tr>
<td>3</td>
<td>Teacher</td>
<td>Same Teacher</td>
</tr>
<tr>
<td>4</td>
<td>Sex</td>
<td>Male and Female</td>
</tr>
<tr>
<td>5</td>
<td>Time</td>
<td>First half of the day and immediately after the long recess</td>
</tr>
</tbody>
</table>

4.4 SAMPLE

There are near about 500 High schools in Nagpur city. A purposive sample was used for the study. The Head Masters of the six Marathi medium high schools were contacted in respect of performing the experiment during the academic session 2004-2005. From these three highschools with two sections each of IX class were randomly chosen. On the basis of similarity in marks obtained by the students in VIII class and size. These students of the three schools were given a test on some topics of science of VIII class to compare their intelligence. Descriptive statistic in respect of size, mean score and standard deviation of the scores obtained by the students in each of these schools is given in the Table-4.2

Table 4.2
Summary of the three schools selected for the study

<table>
<thead>
<tr>
<th>School</th>
<th>Size</th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>134</td>
<td>26.92</td>
<td>7.90</td>
</tr>
<tr>
<td>2</td>
<td>136</td>
<td>27.04</td>
<td>8.35</td>
</tr>
<tr>
<td>3</td>
<td>140</td>
<td>26.10</td>
<td>7.68</td>
</tr>
<tr>
<td>Total</td>
<td>410</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
On the basis of this data, these three schools were similar in respect of the age, size, average scores and S. D. of the test scores and hence the groups were assumed as comparable. Hence the initial sample consisted of 410 students.

4.4.1 Final Sample

These three schools 1, 2, and 3 were then considered as group A, group B and group C respectively for the purpose of treatments. The group A and group B were chosen for the treatment under Concept Attainment Model and Inductive Thinking Model of teaching respectively hence these groups were considered as the experimental groups. While group C was kept controlled to use the Traditional Method of teaching. So it was turned as a control group.

During the experiment each group lost some students due to various reasons such as absence for one or more of the tests, attendance below 80% in the experimental session, withdrawal of name from the role and transfer from the school.

Final analysis therefore had to be restricted only to those students who were regular for the whole experimental session. Descriptive statistic of the data in respect of size, mean score and standard deviation of the scores obtained by the students for these final groups has been given in the Table – 4.3.

Table-4.3
Summary of the three Groups for Final Sample

<table>
<thead>
<tr>
<th>Group</th>
<th>Size</th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>125</td>
<td>26.88</td>
<td>7.89</td>
</tr>
<tr>
<td>B</td>
<td>125</td>
<td>27.16</td>
<td>8.12</td>
</tr>
<tr>
<td>C</td>
<td>127</td>
<td>26.17</td>
<td>7.73</td>
</tr>
<tr>
<td>Total</td>
<td>377</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Due to loss of some students in each group the final sample were consisted of 377 students. Among the sample group A comprised of 125, group B comprised of 125 and group C comprised of 127 students. It can be observed from Table-4.2 that the three groups formed were still fairly comparable on these pre-experimental measures.

4.4.2 Achievement in VIII Science

The scores in the test given on VIII science for the purpose of testing similarity of the groups were obtained which were to be used as co-variates for the data of experimental groups A and B and the control group C. The rational behind using it as co-variate has already been explained. The experimental group A obtained mean score of 26.88, with its standard deviation 7.89, group B has mean score of 27.16, with its standard deviation 8.12 and the control group C has mean score of 26.17, with its standard deviation 7.73. These values indicate the groups to comprise of average students on Science Achievement.

The minimum score in-group A was 13 and maximum score was 45 showing this group to have a range of 32. In-group B the minimum score was 12 and maximum score was 45 showing this group to have a range of 33. While in-group C the minimum score was 13 and maximum score was 45 showing this group to have a range of 32. The mode and median for group A were 24.83 and 26.19 respectively; for group B it were 24.93 and 26.41, while for group C these were 23.91 and 25.42 respectively. The skewness for group A was 0.26, for group B was 0.277, and for group C was 0.292. The kurtosis values for these groups A, B and C were 0.264, 0.264 and 0.259 respectively.

The intercomparison and intracomparison of means, medians and modes of these three distributions also showed that they did not differ significantly implying the three distributions to be normal and similar. Graph 4.1 shown below represents the similarity among the groups.
Graph-4.1
Graphical Representation of Test Scores of Group A, B, and C on VIII Science

Scores in Test on VIII Science
Group- A

Scores in Test on VIII Science
Group- B
Thus, it can be said that group A, group B and group C do not differ on Achievement of students in VIII class Science.

F-ratio of the variations among groups A, B and C and within group variations is 0.52 which is not significant at 2/374 degrees of freedom, thereby reinforcing that groups A, B and C did not differ significantly on Achievement of students in VIII class Science. This observation is further strengthened by non-significant t-values of the means of pairs AB, BC and AC in these groups. As the three groups did not differ significantly on test in Achievement in VIII Science they could directly be compared using ANOVA on the related variables like Reasoning Ability, Scientific Creativity and Attitude Towards Science.

The following graphical representation, Graph-4.2 shows the comparison of individual mean scores on Achievement of students in VIII class Science of all the three groups and their combined mean score. In this graph the mean score of group A, group B and group C have been plotted around the combined mean score of these groups represented by a bar diagram.
Graph-4.2
Comparison of Mean Scores of the Test on VIII Science
of Groups A, B and C, with Combined Mean Score

This graph shows that all the three groups have been set in such a way that their mean score lying near the combined mean score of these groups. This defines that the three groups are formed equally.

4.5 TOOLS

As per the objectives of the study to measures the subjects during pre-test and post-test on the criterion variables following tools were used for collecting data.

1. Lessons based on Concept Attainment Model of teaching on some topics in IX class science.

2. Lessons based on Inductive Thinking Model of teaching on some topics in IX class science.
3. Researcher develops an Achievement Test, which was based on selected topics of IX class Science.

4. Reasoning Ability Test (RAT) in Hindi by K. Bayati (1984) was used for the measurement of Reasoning Ability of the students.

5. Verbal Test of Scientific Creativity (VTSC) in Hindi by V. P. Sharma and J. P. Shukla (1985) was used for measuring Scientific Creativity of the students.

6. Science Attitude Scale (SAS) in Hindi by Avinash Grewal (1990) was used for measuring Attitude of the students Towards Science.

4.5.1 Choice of Content

Content was chosen from the syllabus of science-I for IX grade students. In this study the selected contents are motion, equation of motion, force, classification of force, work and energy and heat. The lesson plans were prepared on each content, which are based on Bruner’s strategy, Hilda Taba’s strategy, and Traditional Method of teaching.

4.5.2 Lesson Plans based on Concept Attainment Model, Inductive Thinking Model and Traditional Method of Teaching

The subject matter to be contains six chapters of IX class science-I as mentioned in 4.5.1. From the total prepared lesson plans for each group, six lesson plans in detail have been given in Appendices A, B and C, which contains two lesson plans according to Bruner’s Concept Attainment Model, two lesson plans according to Hilda Taba’s Inductive Thinking Model and two according to Traditional Method of teaching. Formats of these lesson plans based on the three strategies of the teaching are given in the following three sub-sections.

I) Format of Lesson Plan based on Concept Attainment Model

Lesson plans of Bruner’s Concept Attainment strategy included the following steps (Appendix-A):
a. Name of the concept
b. Statement of Behavioural Objectives
c. Presentation of the Data and identification of Concept
   i) Teacher present labeled examples
   ii) Students compare attribute in positive and negative examples
   iii) Students generate and test hypothesis
   iv) Students state a definition according to the essential attributes
d. Testing attainment of the Concept
   i) Students identify additional unlabeled examples as yes or no
   ii) Teacher conforms students’ hypothesis, names concept and restate definition according to essential attributes
   iii) Students generate examples
e. Analysis of Thinking Strategy
   i) Students describe thoughts
   ii) Students discuss role of hypothesis and attributes
   iii) Students discuss type and number of hypothesis.

II) Format of Lesson Plan based on Inductive Thinking Model

Lesson plan pertaining to Hilda Taba's strategy included the following steps (Appendix-B):

a. Introduction
   i) To arouse the previous knowledge
   ii) Naming the Concept
b. Statement of Behavioural Objectives
c. Concept formation
i) Enumerate and list

ii) Group

iii) Label, categorize

d) Interpretation of Data

i) Identify dimensions and relationships

ii) Explain dimensions and relationships

iii) Make inferences

e) Application of Principles

i) Hypothesize, predict consequences

ii) Explain and/or support the predictions

iii) Verify the prediction

III) Format of Lesson Plan based on Traditional Method of Teaching

Lesson plans of Traditional Method of teaching included the following steps (Appendix-C):

a) Introduction

i) To arouse the previous knowledge

ii) To create atmosphere to learn the topic

b) Statement of aim

c) Presentation of concept

d) Recapitulation of gained knowledge

e) Homework for self-study

4.5.3 Achievement Test

The investigator prepared the Achievement Test for IX class of students on some topics of Science. It is device through which it is possible for the
teacher to have a complete knowledge about the students and his knowledge of the subject taught. It attempts to measure what an individual has learned, his or her performance level. It is also possible to compare the achievement of different students and the effectiveness of different instructional methods.

In present study, the test is designed to measure what the students have learned at the end of the experiment. In Achievement Test total fifty questions were asked on the selected topics of Science for IX class students. While preparing these items due representation was given to most of these categories knowledge, understanding, application and skill have been included in the test with due weightage to each of them.

I) Development of Achievement Test

In the development of Achievement Test, the researcher followed following steps:

1. The course content for the test was from the Science-I of IX class students, recently prescribed by the State Board of Secondary and Higher Secondary Education.

2. The investigator referred various related books, journals and the reviews of the researches done for the preparation of Achievement Test.

3. Due consideration were given to different units of science-I as prescribed.

4. Various issues were discussed with the subject teachers and the experts in the concerned field with their suggestions.

5. Questions in the test were selected on the basis of difficulty level and discrimination.

6. Preliminary try-out was taken for collecting the statistical evidence about the individual items and about the test as a whole. And time required by the students for the test was recorded.
II) Item Analysis

Initially the investigator prepared a test with 80 items of multiple-choice questions with weightage of one mark each for correct answer and zero for the wrong answer. This test was administered on a small representative sample of 60 students containing both boys and girls studying in IX class.

Time allotted for the completion of test was one and half-hour.

A test, apart from serving the purpose of appraising the progress of students, has a diagnostic function to perform. The analysis of responses helps the teacher to study the learning of class and its failure to learn certain things.

The answer papers of the test based on IX science were arranged in order from the highest score to lowest score. Then 15 papers with highest scores and 15 papers with the lowest scores, which is count of 25 percent of the best and 25 percent of the poorest responses (Dandekar, p-139), were selected. For each test item, tabulate the number of students in the upper and lower groups who selected each alternative. The difficulty of each of the item was estimated and then discriminating power of each item was also estimated.

a) Estimating Item Difficulty

For estimating item difficulty the formula used as

\[ \text{Difficulty} = \frac{R}{N} \times 100 \]

Where,
R = Number of pupils who got the item right.
N = Total number of pupils in the two groups U and L.

b) Discriminating power of an item

The discriminating power of a test item refers to the degree to which it discriminates between the bright and the dull pupils in a given group.
If all the students from the upper and lower group answer an item correctly or if all fail to answer it correctly, the item has no validity, since in neither case does the item separate the good from the poor members of the class.

An estimate of an items discriminating power can be obtained by the formula:

\[
\text{Discriminating Power} = \frac{U - L}{\frac{1}{2}N}
\]

Where, U – Number of pupils from the upper groups, who got the item right.
L – Number from the lower group, answering correctly.
N – number of pupils in the two groups U and L.

c) Final form of the Test

Item analysis of the preliminary form of the test provides the basis for revising the test and for preparing the final form to be administered. Items are selected by considering the difficulty and discrimination of each item from 0.21 to 0.65 in the final form of the test. Selected items were then arranged in an ascending order of difficulty. In this manner the fifty multiple-choice items were include in this test. While preparing these items due represents was given to most of these categories like knowledge, understanding, application and skill have been included in the test with due weightage to each of them.

This test contains the topics of IX class Science such as motion, equations of motion, force, classification of force, work and energy and heat with due weightage to each of them. A separate answer sheet was also designed for this test. The time of 75 minutes was determined for this fifty items test. The detail regarding (contents) topics and number of items with due weightage to each of them is given in the Table – 4.4
Table-4.4
Weightage to the Contents in
Achievement Test in Science

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Topic</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Motion</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>Equation of Motion</td>
<td>04</td>
<td>08</td>
</tr>
<tr>
<td>3</td>
<td>Force</td>
<td>11</td>
<td>22</td>
</tr>
<tr>
<td>4</td>
<td>Classification of Force</td>
<td>07</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>Work and Energy</td>
<td>06</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>Heat</td>
<td>07</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

The details regarding objectives and number of items with due weightage to each of them is shown in Table - 4.5

Table-4.5
Weightage to the Objectives

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Objective</th>
<th>No. of Items</th>
<th>Weightages in percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge</td>
<td>16</td>
<td>32%</td>
</tr>
<tr>
<td>2</td>
<td>Understanding</td>
<td>18</td>
<td>36%</td>
</tr>
<tr>
<td>3</td>
<td>Application</td>
<td>10</td>
<td>20%</td>
</tr>
<tr>
<td>4</td>
<td>Skills</td>
<td>06</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>Total Items</td>
<td>50</td>
<td>100%</td>
</tr>
</tbody>
</table>

III) Validity and Reliability

Validity is defined as the accuracy with which a test measures whatever, it purports to measure. A test is valid, if it meets the purpose for which it was designed.
Validity of the test depends on the degree of measurement of the test that able to meet the requirement of the objectives of the teaching science-I of IX class. In the present study researcher used the content validity of the test for analyzing the item distribution among different topics and giving appropriate weightage to each topics. Content validity refers to the degree to which the test actually measures or is specifically related to the traits for which it was designed.

Opinions of experts and experienced subject teachers were sought on the appropriateness of the analysis of item distribution and selection of the proper questions in the test. After the preliminary try-out difficulty level and discrimination of each questions in the test were determined. Fifty questions with specific difficulty level and discrimination were selected for the final test. In this way the test was considered as a valid test.

The second important quantity of a measuring instrument is its reliability. A reliable test is one, which measures accurately and consistently. If a reliable test is given two or three times to the same group, each person in the group should get appropriately the same score on all occasions.

There are various methods of estimating the reliability.

- Test-Retest Method
- Parallel Forms Method
- The Split Half Method
- Rational Equivalence Method

For determination of reliability of test, researcher used the two methods, Test-Retest Method and Split Half Method.

1. Test-Retest Method

The Achievement Test was administered on the small sample of 60 students. The same test was given to the same sample after fifteen days and
correlation coefficient between the two sets of scores was determined. This
coefficient of correlation \((r = 0.87)\) is the coefficient of reliability for the test, which
shows the high correlation between the test scores.

2. Split Half Method

Questions in the test were arranged in ascending order according to the
difficulty level of each item. Then the test was divided into two subtests selecting odd
number of questions (i.e. 1, 3, 5, 7, ... 49) is the first test and even number of
questions (i.e. 2, 4, 6, 8, ...50) in the second test. These two tests were equivalent in
terms of difficulty in content. Both the tests were administered on the sample of 100
students at the same time and correlation coefficient between the scores of these two
tests was determined (i.e. \(r_{h1} = 0.94\)).

The reliability coefficient of the whole test \((r_{w1} = 0.97)\) was then
determined by using Spearman-Brown formula

\[
r_{w1} = \frac{2 \cdot r_{h1}}{1 + r_{h1}}
\]

Where

\(r_{h1}\) = Reliability coefficient of half tests.

\(r_{w1}\) = Reliability coefficient of whole tests.

This reliability coefficient shows that the test is reliable.

Thus from the above observations on validity and reliability mentioned
above, it indicates that Achievement Test on IX Science developed by the investigator
is reliable and valid.

IV) Scoring

Finally the Achievement Test on IX class of science contains 50 items
having weightage of one mark each for correct answer and zero mark each for wrong
answer accounting total scores of 50 marks.
4.5.4 Reasoning Ability Test

There are various tests on Reasoning Ability, some of the tests are mentioned below:

1) Reasoning Ability Test (RAT) in Hindi, by L. N. Dubey (1977), for 12 to 17 years students, standardized on a sample of 1460.

2) Reasoning Ability Test (RAT) in Hindi, by K. Bayati (1984). It is standardized on 2800 Higher Secondary boys and girls of age group 15 to 16.

3) Reasoning Ability in Science (RAIS) in English, by Anuradha Josi and B. C. Mahapatra. This test measures Reasoning Ability in Science with the help of five types of Reasoning analogical, classification, electric, deductive and inductive through 43 items meant for 10+2 students.

Of the above test given, the investigator preferred Reasoning Ability Test developed by K. Bayati (RAT) for the study to measure the students Reasoning Ability.

Reasoning is the process of controlled thinking as association, which starts with some problems of interest to the reasoner and is directed towards its solution. It differs from ordinary imagination in that the results of reasoning are suppose to check with some outside criteria, that is they are supposed to be correct while such checks are not necessarily required in imagination.

There are two different kinds of reasoning – inductive and deductive. Inductive thinking attempts to work out a general rule, explanation, principle or idea to explain or cover a group of particular cases or to solve same type of problems. Deductive thinking starts with some accepted general principle and applies it to a particular case or problem. As we grow older we acquire many general principles that we accept. Some of these come from our own induction; some from our studies in schools; some come from our parents and other associates; some are picked up unconsciously from our environment without knowing exactly their source.
Since reasoning starts with some unsolved problem, we must, if we wish, train our students to reason, and make them conscious of problems to be solved. It is futile to attempt to get reasoning simply by administering students to think. If a child is not acquainted with a particular problem, how can we think about it?

The test has productive value of Reasoning Ability. Reasoning Ability is highly correlated with problem solving ability and mathematical ability. With the help of this test we can find whether the child is capable of solving problems. It also enables us to find the ability to see the cause and effect.

The reliability coefficient of the test was determined by using the Split Half Method and it is found 0.41. This test has been validated against L. N. Dubey’s test of Reasoning Ability.

I) Administering the Test

i) Test administrator should ensure that the seating arrangement should be comfortable. Pupil should get sufficient light and ventilation.

ii) The entire pupil should have pens or pencils. For emergency, the tester should have some pencils ready with him.

iii) Not more than 30 pupils should be given test at a time.

iv) One supervisor should assist the tester.

v) The time limit is only 70 minutes.

II) Scoring

There are 84 questions in the test. One mark for each correct answer and zero mark for the wrong answer should be awarded. The range of marks is from zero to 84.
4.5.5 Verbal Test of Scientific Creativity

There are different types of test of Creativity out of which some of the tests are given below:

1) Test of Creativity (PTC) in Hindi / English by B. K. Passi, it includes four subtests. It is standardized on 600 students of both sexes of urban and rural background of grades X to XI.

2) Verbal Test of Creative Thinking (TCW) in Hindi / English by Baqer Mehdi (1985). It provides three factor scores – fluency, flexibility and originality.

3) Non-Verbal Test of Creative Thinking (TCW) in Hindi / English by Baqer Mehdi. It provides two factor scores – elaboration and originality.

4) Verbal Test of Scientific Creativity (VTSC) in Hindi/English by V. P. Sharma and J. P. Shukla (1985). It consists of 12 items which have been classified into four subtests.

5) Language Creativity (LCT) in English language by S. P. Malhotra and Sucheta Kumari. This test includes 27 items and it measures total language creativity and its four components fluency, flexibility, originality and elaboration.

For the present study investigator had selected Verbal Test of Scientific Creativity developed by Dr. V. P. Sharma and Dr. J. P. Shukla (1985) as it is related to Science and was used by number of researchers for measuring the Scientific Creativity of IX class students.

Scientific creativity may be considered from the following points of views:

i) Scientific Creativity deals with the unusual and original excellence in the field of Science or Scientific Productivity.
ii) Scientific Creativity can also be taught as scientific method or scientific process primarily involved in production of unusual and original scientific contribution.

iii) The unusual scientific thinking abilities characterized by systematic approach for all contents whether from science or humanities or otherwise could be considered as the basic attribute of Scientific Creativity.

The Verbal Test of Scientific Creativity includes four subtests, namely consequences test, unusual uses test, new relationship test and just think why test.

1) Consequences Test

The consequences test is designed on the test patterns of Guilford (1952) and Torrance (1962). In this test the familiar things are presented in the form of a hypothetical situation. The subject has to visualize a large number of possibilities to a hypothetical happening. This applies to cause consequence relationship. The subject has to think the effects of consequence whether usual or unusual, logical or illogical.

The consequences test consists of three hypothetical situations arising from fundamentals of science.

i) What would happen if there is no earth in the world?

ii) What should happen if there are no bones in human body?

iii) What would happen if there is no air on the earth?

The situations are the hypothetical ones hence the experience is minimized. An example is given in the test book-let to make the students familiar with the test. The time allowed for the test is 15 minutes.

2) Unusual Uses Test

The test of unusual uses has been designed on the lines of Guilford’s (1952) Brick Uses Test and Torrance’s (1962) Tin Can Uses Test. The
present test of Scientific Creativity includes the names of the common objects; namely

i) Nails

ii) Water and

iii) Leaves of plants and trees.

This can be used for numerous purposes. All these items are very common objects from the fields of physical and biological sciences. They do not require in any way the knowledge and skill in science; however, vertical scientific thinking is an essential requirement for attaining high on this test. The students are required to unite many novel, interesting and unusual uses of these objects as they may think. One practice item is given in the book-let to acquaint the pupil with nature of activity that he has to do, time allowed here is also 15 minutes.

3) New Relationship Test

The New Relationship Test has been designed on the pattern of Mednick's (1962), Remote Association Test. In this activity, the articles of daily use with which the child is familiar are taken so that he may think more naturally. All the articles of this test are scientifically belonging to the same group.

This new Relationship Test consist of three pairs of words, namely

i) Sugar and salt

ii) Oil and water and

iii) Cat and dog.

Which are similar to some extent in some of their physical, chemical or biological properties? A student has to think as many new and novel similarities between these pairs of familiar objects from physical and biological sciences. This permits and subjects an opportunity for free play of their imagination in the production of novel, original and unusual responses. One practice item is given in the test booklet. Time allowed is fifteen minutes.
4) Just Think Why Test

The Just Think Why Test of Scientific Creativity consists of common events based on cause effect relationship. The subjects are asked to think various causes of the events.

This test contains three events namely:

i) What are the occasions for increase in heart beating?

ii) What are the reasons for non-generation of the seed?

iii) On which occasion the man is not able to express his thought?

The child has ample opportunity to imagine and to produce novel and original ideas. Time allowed is fifteen minutes.

I) Administration

This Verbal Test of Scientific Creativity includes four subtests, namely consequences test, unusual uses test, new relationship test and just think why test. Time allotted to each activity is 15 minutes, which should be strictly adhered to. The total time required to administer the whole test of Scientific Creativity is one hour in addition to 20 minutes time for general instructions and practice items.

II) Scoring Technique

While scoring it is to be kept in mind that each item is to be scored for fluency, flexibility and originality. The definitions of these terms are given below:

a) Fluency

Fluency is represented by the number of relevant and unrepeated ideas, which the testee produces. Relevance is judged on the basis of the appropriateness of the response when considered in relation to the test problem. An unrepeated idea is one which has been expressed only once under a given problem. Thus fluency has been scored in terms of total number of unrepeated responses related to the object.
b) Flexibility

Flexibility is represented by a person's ability to produce ideas which differ in approach or thought trend. All ideas which fall under one category of approach or thought trend are treated as one for purposes of flexibility scoring. Thus if five ideas are produced and belong to only one category of approach or thought trend, then the score for flexibility will be one. But if all the five ideas are based on five different approaches or thoughts trends, then the flexibility score will be five. Thus flexibility has been scored in terms of total number of categories.

c) Originality

Originality has been scored in terms of weights assigned in accordance with their degree of unusualness. Weights for originality for probable responses are provided in the key given in the manual.

The scores may be directly entered on the answer sheet.

In the present study, the creativity scores of students are taken as the sum of the total of the creativity scores on each subtest.

The co-efficient of stability as an index of reliability on various components of Scientific Creativity as well as on the whole test has been estimated by test-retest method. The reliability of the whole test is 0.73.

This test has been validated against B. Mehdi's Verbal test of Creative Thinking. Inter factor correlations were also computed as indices of validity, which were found very high indicating dependability and relevance. The validity of the test is 0.98.

4.5.6 Science Attitude Scale

There are different types of attitude test of which some of the tests are mentioned below:

1) Attitude Scale Towards teaching by Yadav and Pandya.
2) Scientific Attitude Test by M. J. Rabindranath.

3) Mathematics Attitude Scale by M. R. Tuli.

4) Attitude Scale Towards Education (ASTE) in Hindi S. L. Chopra.


6) Attitude Towards Teaching by V. V. Katti, Bannur, Ponnam Balam, Visvesaran.

7) Scientific Attitude Test (SAT) in English by Gakhar and A. Kaur.

From the various tests mentioned above, Science Attitude Scale developed by Dr. (Mrs.) Avinash Grewal, was selected by the investigator for measuring the students Attitude Towards Science.

The science attitude has been defined as a generalized Attitude Towards the universe of science content and being measured in terms of its favourableness or unfavourableness estimated from the scores obtained by the subjects on an Attitude scale Towards Science comprising of the four categories from the universe of content ‘Science Attitude’:

i) Positive intellectual

ii) Negative intellectual

iii) Positive emotional and

iv) Negative emotional attitudes

I) Scoring

Science Attitude Scale contains 20 items. Each of the ten positive items (Sr.No.2, 4, 6, 8, 10, 12, 14, 16, 18 and 20) of the scale is assigned a weight ranging from 4 (strongly agree) to zero (strongly disagree). In the case of ten negative items (Sr. No. 1, 3, 5, 7, 9, 11, 13, 15, 17, 19) the scale scoring is reverse ranging
from zero (strongly agree) to 4 (strongly disagree). The attitude score of a subject is
the sum total of scores on all the twenty items of the scale. For each student the total
score on the scale can be obtained by summing his scores for the individual items.
Thus a maximum of 80 scores can be obtained by a subject. However, the
demonstration on the test reveals that the scores ranged from 25 to 70.

II) Time for Administration

The Science Attitude Scale is a self-reporting inventory consisting of
20 items designed to assess the Attitude of individuals Towards Science. There is no
time limit but normally it takes about 5 minutes to explain the test and the subjects
required about 15 minutes for giving responses to the items of the scale.

The reliability of the Science Attitude Scale (SAS) was estimated by
the Split Half (0.86) and Test-Retest (0.75) methods, which was found to be quite
satisfactory. This compares favourably with reliability (0.765) found by Sood (1975)
for his scale of Attitude Towards Science and Scientists. Reliability of the scale was
further checked by two methods of scoring by administering the scale to a small
sample of 50 subjects with instructions to check the statements in accordance with the
usual Thurstone’s instructions and the science subjects were then asked to check for
each item on one of the five alternatives in accordance with the usual Likert
instructions.

The coefficient of correlation found between the scores on two scales
was 0.94. Ferguson (1941) reported a correlation of 0.82 between the Thurstone and
Likert methods of scoring.

The Science Attitude Scale appears to have content validity and the
method of selecting items supports this supposition. In addition, difference in mean
scores were found among the selected groups of known preference for science i.e.
Arts (Mean = 46.41) and Science (Mean = 50.58) students which is highly significant
(t = 6.62) at 1 percent level.
the researcher would continue to teach for nearly two and half months covering major topics in their syllabus.

**Table 4.5**

**Phases of Experiment**

<table>
<thead>
<tr>
<th>Group</th>
<th>Phase-I</th>
<th>Phase-II</th>
<th>Phase-III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Pre-test)</td>
<td>(Treatment)</td>
<td>(Post-Test)</td>
</tr>
</tbody>
</table>

- **Experimental Group A**
  - 1. Measurement of students' Reasoning Ability.
  - Teaching science through Concept Attainment Model of teaching

- Phase III
  - 1. Measurement of students' Reasoning Ability.
<table>
<thead>
<tr>
<th>Group</th>
<th>Phase-I</th>
<th>Phase-II</th>
<th>Phase-III</th>
</tr>
</thead>
</table>
In order to measure the effect of her teaching, researcher would like to know their present position, students were instructed that they would be given some tests in the following three periods so they must not miss.

All the three groups then administered the three tests, Reasoning Ability Test, Verbal Test of Scientific Creativity and Science Attitude Scale one by one. The administration of these tests was carried out as per norms and instructions in their manuals. The periods allotted to the researcher fell on different days and at different times. Hence, it was not possible to administer the given test to all the three groups on the same day or at the same time of the day.

During testing, researcher has been taken care that students did not get any chance to copy answers from the neighbouring students. For this work, subject teachers were requested to help researcher. The work of pre-testing was over at the end of the second week on July 2004.

After administering the said tests, they were scored on all the above said variables, which served as the pre-test scores of the sample students on the respective criterion measures. Thus the pre-test scores were obtained on Reasoning Ability, Scientific Creativity and Science Attitude Scale in all the three groups.

4.6.3 The Treatment

To find the effectiveness of the independent variables, they were manipulated in the form of teaching based on Concept Attainment Model, Inductive Thinking Model of teaching and Traditional Method of teaching to criterion group. The lessons planned were from science-I of their course of study in science of IX class. Twenty-seven structured lesson plans were prepared for each of the model and Traditional Method of teaching. Model lesson plans are given in the appendix A, B and C.

The researcher started her experimental teaching from the beginning of 3rd week of July 2004 and continued for two and half months, which ends in the first week of October 2004. This particular period was chosen for the following reasons:
1. During this period, there were no school examinations to cause undesired anxiety to students.

2. Since the period of treatment falls after the long summer holidays, the students were with a feeling of joy.

The groups A and B were selected to teach through Concept Attainment Model and Inductive Thinking Model of teaching respectively so they were to be considered as experimental groups. Group C was selected to teach through Traditional Method of teaching. Hence, it was considered as a control group. Same topics were selected to teach all the three groups in 27 periods of 30-35 minutes duration each.

The researcher herself started teaching to all the experimental groups in all different schools. Researcher conducted the experimental teaching in these schools simultaneously. The time-table was, therefore, so arranged that all the experimental groups should not fall on the same day in order to avoid contamination between the experimental strategies.

The periods for the experimental teaching were arranged during the school time-table in place of Science periods. Out of four periods per week, two periods were adjusted in the first half and other two periods immediately after the long recess. The periods of Concept Attainment Model of teaching on group A were taken on Monday, Thursday (first half) and Wednesday; Saturday (immediately after the recess). The periods of Inductive thinking Model of teaching on group B were taken on Tuesday, Friday (first half) and Monday, Thursday (immediately after the recess) and those of Traditional Method of teaching on group C were taken on Wednesday, Saturday (first half) and Tuesday, Friday (immediately after the recess).

Teaching was done according to the lesson plans prepared in advance as per requirement of the models. During the inquiry session the students were allowed to discuss among themselves. It has been observed that the students of all the three groups enjoyed the lessons. Normally, the planned lesson was completed in one
class period and the inquiry was continued for the short span in the next period. Teachers helped in recording the actual question asked by the students. There was no discontinuity in the program except some holidays and specific activities of the school.

The work of the treatment was over in the first week of October 2004 (Table-4.5).

4.6.4 Post-Test

Immediately after the treatment was over the subjects were administered the post-tests for all the treatment variables using the same criteria tests as in the pre-test during first and second week of the October 2004. To see the students’ Achievement in IX class Science, the post-test scores were measured through Achievement Test, which was based on IX Science. To see the efficacy of the treatment on Reasoning Ability, the post-test scores on Reasoning Ability were measured through Reasoning Ability Test (RAT) of K. Bayati. The Scientific Creativity as a result of treatment was measured through the Verbal Test of Scientific Creativity (VTSC) of V. P. Sharma and J. P. Shukla. The change in Attitude Towards Science was observed with the help of the Science Attitude Scale (SAS) of Avinash Grewal.

Students were informed about the testing only a week earlier. Subject teachers were requested to make proper seating arrangement for the test, which they did without fail.

Each of the three groups of sample students were subjected to these post-tests, one by one, as per procedure simultaneously to avoid possible inter-group interaction. Subject teachers helped the researcher in keeping strict supervision. In this way post-test scores were determined for students Achievement in Science, Reasoning Ability, Scientific Creativity and student’s Attitude Towards Science in all the three groups.
The work of whole experiment was over in the second week of October 2004 (Table-4.5).

4.7 PRECAUTIONS OBSERVED

Following precautions were observed during the course of experiment for ensuring effectiveness and high precision in experiment conditions, which may have contributed to results:

i) All the subjects were oriented to the tests and respective models of teaching as per their treatment in the beginning of the treatment.

ii) Testing as well as teaching was simultaneous in the three groups (during pre-test, treatment and post-test) to avoid inter-group interaction.

iii) All the subjects were taught by the investigator herself to avoid any variation in teacher variable.

iv) No undue stress or control of any kind was imposed on the subjects at any time during the study and the experiment was conducted in a relaxed natural setting.

v) It was ensured that the topics or contents of the treatment had not been previously taught to the students and not even taught by any other teacher during the experiment to any of the three groups A, B or C.

vi) The effectiveness of the experimental treatment was ensured by establishing rapport in the school, maintaining natural setting, harmonious atmosphere, providing sufficient time for various activities in the experimentation and the like.

vii) Care was taken not to undermine the importance of content matter or the subject matter during the course of treatment and it was not underplayed while fitting into the models of teaching.
viii) During each of the three treatments, attempts were made to stick to the
tenets of the specific model for treatment to the respective group and
not to deviate from the steps specifically made in the lesson plans of
the treatment during execution.

ix) Separate material was provided for every student during
experimentation so as to avoid any disturbance or chances of unfair
observations. Thus it was ensured that the material provided to the
students for testing, treatment or during orientation was adequate to
meet their demand.

x) Teaching periods of 30-35 minutes duration were utilized fully for
treatment and time was not wasted during experimentation.

4.8 DIFFICULTIES FACED DURING EXPERIMENT

Constraints and difficulties faced during the experiment are

1) It is quite an effort to make the Teachers and Headmasters agree to
co-operate in the experiment. The Head Masters of other schools
refused to allow the conduct of the experiment on pre-text or the other.
Some said the parents would object to it, others said they could not
take the risk of wasting students’ time while others showed their
inability to permit due to administrative reasons.

2) In the experimental schools, some times a few subjects were not
present or were irregular. It is an essential requisite for every
experiment that the treatment is fully provided to every student, which
implies his/her, regular presence in the school during the days of the
treatment. Thus, it was ensured that the sample groups were regularly
attending the schools excepting some unavoidable circumstances.
However, no experimental treatment was executed when the
attendance was meager or very poor in these classes.
3) During the orientation of the students towards their respective models of teaching some difficulty was faced. In the beginning the students appeared to be hesitant to come forward with responses and views but with the passage of time, the students began to take interest in teaching learning activities.

4) During the process of making lesson plans for the treatment some difficulty was faced. Since these were the strategies meant for specific purposes, it was some time not possible to adopt certain content of the treatment according to the model of teaching in the lesson plan and hence, that too had to be accommodated according to the specified method.

5) The investigator had to teach the lessons as per their syllabus and term schedule also, as they were pursuing a regular course of studies. Thus the experiment schedule had to be adjusted accordingly.

6) Ideal atmosphere for the treatment in the classroom was difficult to be created. It was difficult to motivate and create interest of all the subjects in that model of treatment.

7) During the pre-test and post-test it was difficult to arrange their seating plan and time Table. Since every test had to be conducted within the same period which was a short duration of 30-35 minutes, to avoid the problem of completing these tests were conducted in the last period or period before recess so that recess could be utilized or could continue the test even when the school was over.

8) In spite of all efforts, 43 out of 420 students did not take part in all the experiment. Some of these students were absent, some withdrew from the school, some of them were promoted to the next higher class in between the experiment due to their being compartmental candidates,
some did not take all the tests and the like besides the cases of truancy. Thus the final sample consisted of 377 students.

9) Interaction among the experimental groups and the control group during the treatment could not be completely ruled out or controlled despite best efforts during the course of the experiment, though ideally it should be.

10) Specific events like anxiety fatigue or interest and the like factors were beyond the control of the experimenter. These could have a stimulating or disturbing effect upon the performance of the subject. These factors were not taken into account. However, their effect cannot be more than marginal.

11) Factors like home environment, self-concept, adjustment, social maturity and the like could also have a marginal effect upon the experiment but have not been taken into account.

12) Resources with students, extra reading habits, and similar factors too were not taken into account in the experiment.

13) Teaching by other subject teachers in their own periods and subjects through other teaching methods or strategies than that in experiment and their interactive effect on the on the sample students could be differential which might have effected the experiment but were not taken into account.

4.9 STATISTICAL TECHNIQUE FOR DATA ANALYSIS

The data collected by administration of pre-test and post-test measures to the three groups was analyzed using appropriate statistical technique.

Descriptive statistics used for summarizing the data were Mean, Standard Deviations, t-test and F - ratio. Although the groups were equated on the
basis of Mean, Median, Mode, S. D., Kurtosis, Skewness and F-ratio of the marks obtained in the test based on VIII class science.

Hypotheses were tested against a probability level of 0.01 and 0.05 level to prevent Type – I error i.e. when we reject the null hypothesis by marking a difference significant although no true difference exists in drawing inferences.

In order to avoid Type – II error i.e. when researcher accept a null hypothesis by making a difference not significant, when a true difference actually exists, the hypothesis, which could have been accepted at 0.01 and 0.05 level of significance.

The study was concerned with development of Achievement in Science, Reasoning Ability, Scientific Creativity and Attitude Towards Science as a result of special treatment.

In case of mean, difference among the groups on criterion measure was indicated by F-ratio, further analysis for the identification of groups between which the mean difference actually existed was done by employing 't'-test.