DESIGN AND PROCEDURE OF THE STUDY
CHAPTER – III

DESIGN AND PROCEDURE OF THE STUDY

3.0.0 INTRODUCTION

Educational research is described as "Experimental" when the researcher has, firstly, specified the finite set of researchable hypotheses and secondly, has established a systematic programme of data gathering under precisely defined conditions in an effort to test these hypotheses. The hypotheses provide a network of statements relating to the impact of independent variables on some outcome variables or dependent variables. (Ingersoll 1982)

Weiner (1977) has rightly remarked that the experimental method which is suitable for testing hypotheses is the strongest available method for developing and understanding psychological aspect. Any experimental problem has two inter-related aspects, the design of the experiment and the statistical analysis of data. The latter aspect is directly dependent upon the former aspect. Statistical methods can increase the efficiency of an experiment and also strengthen the conclusions so obtained (Montgomery, 1984).

The present study has conducted through Pre-test, Post-test experimental design.
The purpose of the present study is to find out the effect of Mastery Learning strategy and Inquiry training model on pupil's achievement in Science, their self concept and creative abilities. The effect will be studied by comparing the achievement, self concept and creative abilities of three groups of pupils taught Science through mastery learning, inquiry training and conventional method of teaching.

This chapter involves the systematic procedure followed, design employed, sample selected, tools used, sequence of events that occurred, procedure adopted for data collection and statistical analysis applied to realise the objectives of the study.

3.1.0 DESIGN

In the present study, pre-test post-test control group quasi experimental design was employed with purposive sample in the form of intact sections of class VII of the same school. It involved three groups of students, two experimental groups and one control group. The Experimental Group I was taught Science through Mastery Learning Model, Experimental Group II was taught Science through Inquiry Training Model and the Control Group was taught Science through Conventional Method. The design comprised three stages. The first stage
involved pre-testing of all the students of three groups on achievement in Science. Socio-economic status, intelligence, creativity and self-concept. The Second stage involved treatment of twelve weeks. The experimental treatment consisted of teaching Six units of VIIth grade Science through mastery learning model to experimental group I, through inquiry training model to experimental group II and through conventional method to control group. In the third stage, the students were post tested on achievement in Science, Creativity and self-concept. A schematic view of the phases of experiment has been presented in table 3.1

**Table 3.1**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Duration</th>
<th>Control Group</th>
<th>Experimental Group I</th>
<th>Experimental Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td>II Treatment</td>
<td>Twelve Weeks</td>
<td>Teaching Science Through conventional Method</td>
<td>Teaching Science through Mastery learning Model</td>
<td>Teaching Science through inquiry training model</td>
</tr>
</tbody>
</table>
3.2.0 VARIABLES

In the experimental researches the relationship between two types of variables namely independent and dependent variables is studied. Independent variables are the causes while dependent ones are effects. Another category of variables, which is equally important, is of intervening variables. All these three kinds of variables which were identified for the study are discussed below.

3.2.1 INDEPENDENT VARIABLES

As the impact of models of teaching had to be studied, the method of instruction or teaching strategy in the form of models of teaching were used as independent variables. Two types of models of teaching viz mastery learning model and inquiry training model were used in this study to see their effect on the achievement of pupils in Science, their creativity and self-concept. The experimental group I was taught through mastery learning model, the experimental group II was taught through inquiry training model and the control group was taught through conventional method. These were the variables that were manipulated to study the effectiveness. Thus, mastery learning model, Inquiry training model and conventional method were the three independent variables for the present study.
3.2.2 DEPENDENT VARIABLES

Achievement in Science, Creativity and Self-Concept were the dependent variables. All these variables were measured twice during the course of the study -- first before beginning the experimental treatment i.e. which is pre-test stage and then after completing the experimental treatment, i.e., post-test stage.

3.2.3 INTERVENING VARIABLES

There are certain variables known as intervening variables which have their effect on the learning outcome, and can influence both the independent and dependent variables. Intervening variables such as nature of school, grade level, subject to be taught, intelligence of pupils, socio-economic status of pupils, previous knowledge of pupils etc, were controlled either experimentally or statistically.

3.3.0 CONTROL EMPLOYED

It is necessary to control all those variables that may significantly affect the dependent variables. Hence such intervening variables were controlled by employing suitable controls.

3.3.1 NATURE OF SCHOOL
The sample was selected from a single Public school (Baba Mast Nath Sr. Sec. School) in Rohtak. It is situated in an urban area of Rohtak.

3.3.2 GRADE LEVEL

Seventh class students were selected for the present study and grade level was thus kept constant during the study.

3.3.3 SUBJECT

All the three groups were taught same units of Science.

3.3.4. SOCIO- ECONOMIC STATUS

The two experimental groups (E₁ & E₂) and control group were given S.E.S Test. ANOVA was applied to find out the difference between S.E.S Test scores of all the three groups. The results are given in table 3.2.

Table 3.2 : F-value of S.E.S Test scores of two experimental groups and control group.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Degree of freedom(df)</th>
<th>Residuals</th>
<th>F Value</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sum of Squares</td>
<td>Mean square variance</td>
<td></td>
</tr>
<tr>
<td>Between</td>
<td>2</td>
<td>150.63</td>
<td>75.31</td>
<td>2.92</td>
</tr>
<tr>
<td>Within</td>
<td>87</td>
<td>2240.70</td>
<td>25.75</td>
<td></td>
</tr>
</tbody>
</table>

83
Table 3.2 shows that the F-value between the three groups is 2.92 which is not significant at .05 level. It means that significant difference does not exist between the S.E.S of the three groups.

3.3.5. INTELLIGENCE OF PUPILS

To eliminate the initial variability of the pupils statistically in all the three groups, they were measured on general mental ability employing Cattell's Culture Fair intelligence test. General mental ability is an index of intelligence which might have effected the independent variables.

ANOVA was applied to find out the difference between intelligence test scores of all the three groups. The results are given in table 3.3.

Table 3.3: F-value of intelligence test scores of two experimental groups and control group.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Degree of freedom(df)</th>
<th>Residuals</th>
<th>F Value</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sum of Squares</td>
<td>Mean square variance</td>
<td></td>
</tr>
<tr>
<td>Between</td>
<td>2</td>
<td>105.63</td>
<td>52.815</td>
<td>2.98</td>
</tr>
<tr>
<td>Within</td>
<td>87</td>
<td>1539.37</td>
<td>17.69</td>
<td></td>
</tr>
</tbody>
</table>
Table 3.3 shows that the F-value between the three groups is 2.98 which is not significant at .05 level. It means that significant difference does not exist between the intelligence of the three groups.

Initially general mental ability was thought to the controlled statistically through covariance but since the three groups selected did not differ on general mental ability at pre-test stage, there was no need to control co-variate.

The independent variables, dependent variables and the control variables with the kind of control employed in the study have been summarized in Table. 3.4.

**Table 3.4**

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Dependent Variables</th>
<th>Control Variables</th>
<th>Control Employed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Self-Concept</td>
<td>2. Grade Level</td>
<td>2. Administrative (only VII was taught)</td>
</tr>
<tr>
<td></td>
<td>3. Creativity</td>
<td>3. Subject to be taught</td>
<td>3. Administrative (same units of Science in all the three groups were taught)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Duration of treatment</td>
<td>4. All the three groups were taught for 72 days of 40 minutes period,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Pupils' socio-economic status</td>
<td>5. No need</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Pupils' intelligence</td>
<td>6. No need</td>
</tr>
</tbody>
</table>
Specific events and factors like anxiety, home environment, adjustment, social maturity and the like could have marginal effect upon the experiment. These factors were not taken into account.

3.4.0 SAMPLE

The sample for the present study comprised of 90 pupils studying in three sections of the VII class of Baba Mast Nath Sr. Sec. School Rohtak. From each section thirty students were selected. One section formed the control group and the other two sections formed the two experimental groups i.e. E₁ and E₂.

3.5.0 TOOLS USED

As per objectives of the study, to measure the pupils during pre-test and post-test on the independent variables and covariate, the following tools were employed for the collection of data:

1.) Science Achievement Test (developed by the investigator herself) was used to measure the achievement of pupils in Science.

2.) Self Concept Questionnaire (SCQ) a test of Self Concept by R.K. Saraswat was used to measure self-concept of pupils.
3.) Cattell's Culture Fair Intelligence Test by Cattell and Cattell was used to measure the intelligence of pupils.

4.) Socio-Economic Status Scale Form A(Urban) developed by Kuppuswamy was used to measure the socio-economic status of pupils.

5.) Test of Creative Thinking by Baqer Mehdi was used to measure the creativity of pupils.

The above tools have been described in detail in the following paragraphs.

3.5.1 DEVELOPMENT OF SCIENCE ACHIEVEMENT TEST:

Achievement testing refers to a sample of indicator of a student's knowledge taken at particular point in time (Ebel, 1979). It can also be thought as the assessment of the outcomes of formal instructions in cognitive domain (Dwyer, 1972). It is helpful to the teacher and students in assessing learning readiness, monitoring learning progress, diagnosing learning difficulties and evaluating learning outcomes.

The investigator made a thorough survey of achievement tests but could not get an appropriate standardized achievement test in Science on the topics selected for the
present study. Therefore, a need was felt to develop an achievement test to evaluate the pupil's knowledge, Comprehension and application.

The different steps followed in developing the test are summarised below:

a) PLANNING THE TEST

Stanley and Hopkins (1978) observed that the planning stage of a test should include the nature of the test and test items and the statement of conditions under which it will be administered. The achievement test was planned with the objective of measuring achievement in Science of VIIth grade students. According to Gronlund (1988), the planning of achievement test takes into account (a) determining the purpose of the test (b) identification and defining the intended learning outcomes (c) preparing the test specifications (d) constructing relevant test items.

b) OBJECTIVES OF THE TEST

For the purpose of constructing achievement test, objectives were defined in behavioural terms from selected chapters of Science text book of class VII. Since the primary concern here was with achievement testing, the focus was mainly on cognitive domain i.e. knowledge, understanding and
application. After determining objectives, the learning outcomes were stated as observable terminal performance. In order to make sure that achievement test provides a representative sample of desired behaviour, test specifications were developed covering the objectives and subject matter selected to be taught during the experiment.

c) CONTENT OF THE TEST

The test covered the contents from the following six units selected for study.

(I) Electric Charges at rest (Different types of charges \(+ve, -ve\))

(II) Energy (Different forms of energy – K.E, P.E, Work etc.)

(III) Life processes (Digestion, Ingestion etc.)

(IV) Air (Pollution of air, different constituents of air – \(O_2, CO_2, \) Water vapours)

(V) Water (Sources of water, types of water, purification of water)

(VI) Sound (Intensity of sound, frequency, wave length of transverse and longitudinal waves)
d) ITEM WRITING

160 objective type items (of Multiple Choice, True-False, Matching type, fill in the blanks and diagram type) were constructed keeping in view the objectives, course content and the expected behavioural outcomes. A large number of items with wide range of difficulty were constructed from six units of Science syllabus prescribed by CBSE for class VII. Every care was taken that no objective remained un-tested and the language of the test items was unambiguous and the instruction were clear. Ten Educationists which included experts in measurement and evaluation, experienced Science teachers and teacher educators were given the preliminary draft of the achievement test. Items which were ambiguous or structurally flawed were either improved or dropped. Finally, 148 items were selected.

Keeping in view objectives, content and types of items, a blue print was prepared as shown in table 3.5:
Table No. 3.5
Blue Print of the Test

<table>
<thead>
<tr>
<th>Objective</th>
<th>Knowledge</th>
<th>Understanding</th>
<th>Application</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic I Electric Energy at rest</td>
<td>8</td>
<td>4</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Topic II Energy</td>
<td>10</td>
<td>8</td>
<td>7</td>
<td>25</td>
</tr>
<tr>
<td>Topic III Life Processes</td>
<td>11</td>
<td>10</td>
<td>6</td>
<td>27</td>
</tr>
<tr>
<td>Topic IV Air</td>
<td>12</td>
<td>9</td>
<td>6</td>
<td>27</td>
</tr>
<tr>
<td>Topic V Water</td>
<td>10</td>
<td>10</td>
<td>7</td>
<td>27</td>
</tr>
<tr>
<td>Topic VI Sound</td>
<td>11</td>
<td>9</td>
<td>7</td>
<td>27</td>
</tr>
<tr>
<td>Total</td>
<td>62</td>
<td>50</td>
<td>36</td>
<td>148</td>
</tr>
</tbody>
</table>

FIRST TRY OUT

The preliminary draft was administered on a population of 30 students to find out the ambiguousness and adequacy of
language of items. Simple instructions were given for filling up the achievement test. The problems faced by the students were noted and as a result of try out 14 Questions were modified.

SECOND TRY OUT

The second try out was given after making corrections as suggested by first try out. The number of the subjects in the second try out was raised to 100. In the first try out, the number of tests was kept low because the clarity of instructions and the language was to be judged. In the second try out the number has to be increased because the investigator wished to go in for item analysis. The achievement test was administered to VIIIth class students individually who have already studied the content. No time limit was fixed for try out test. In average students took 120 minutes to answer all the questions.

The answer scripts were evaluated using scoring key already prepared by researcher. One mark was assigned to correct answer and zero to incorrect answer.

The try-out test and scoring key are given in Appendix-A.
ITEM ANALYSIS

Item analysis was carried out in accordance with Kelley's method (1939), and the following steps were followed for item analysis.

(i) Firstly, all 100 answer sheets were arranged in the descending order from highest score at the top to the lowest score at the bottom.

(ii) Secondly, the upper 27 answer sheets with the highest scores, were selected and were named as 'upper' groups and 27 answer sheets with the lowest scores, constituted the "Lower group". The middle group of answer sheets were left out. Thus 27 answer sheets Constituting upper group and 27 answer sheets making lower group were taken into consideration for computing internal consistency (discrimination index) and the difficulty value.

(iii) After the formation of two groups, the number of correct responses to each item in each group were counted and tabulated. The difficulty of an item is indicated by the total number of correct responses, the larger this number, the easier the item. Item difficulty was estimated by determining the percentage of correct responses to an item. The percentage were converted into proportions. The average of
the proportion of correct responses on each item in the two extreme groups were taken to be indices of the difficulty value of that particular item.

The formula for computing difficulty value 'dv' of each item was:-

$$DV = \frac{R_U + R_L}{2}$$

Where $DV$ = Difficulty value of the item.

$R_U$ = Proportion of right responses in the upper group.

$R_L$ = Proportion of right responses in the lower group.

(iv) Internal Consistency (Discrimination index) (Dp):-

The relationship between the total scores derived from a test and item scores are referred to as discrimination index of an item. It was found out by using the following formula:

$$Dp = \frac{R_U - R_L}{0.5 \times N}$$

where $Dp$ = internal consistency (discrimination index)

$R_U$ = Number of right responses in the upper group.

$R_L$ = Number of right responses in the lower group.

$N$ = Total number of students in both groups.

**FINAL SELECTION OF THE ITEMS:**

Final selection of the items was made on the basis of difficulty value and discrimination index of each item.
(i) **DIFFICULTY VALUE:**

Thus items having difficulty value more than 0.75 and below 0.2 were rejected. Because it has been generally found that an item passed by less than 20% of pupils is considered too difficult and rejected. Similarly items passed by more than 75% of pupils is considered to be easy and hence are not included in the test. On the basis of above criteria 56 items were rejected.

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>D.V.</th>
<th>No. of Items</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Above .80</td>
<td>4</td>
<td>Rejected</td>
</tr>
<tr>
<td>2</td>
<td>.60 to .80</td>
<td>46</td>
<td>Accepted</td>
</tr>
<tr>
<td>3</td>
<td>.40 to .60</td>
<td>46</td>
<td>Accepted</td>
</tr>
<tr>
<td>4</td>
<td>.20 to .40</td>
<td>47</td>
<td>Accepted</td>
</tr>
<tr>
<td>5</td>
<td>Below .20</td>
<td>5</td>
<td>Rejected</td>
</tr>
</tbody>
</table>

**INTERNAL CONSISTENCY (DISCRIMINATION INDEX):**

Discriminating index of a test item refers to the degree to which success or failure on the item indicated the possession of the ability being measured. According to Garrett (1967), items with validity indices of 0.20 or more are regarded as satisfactory. Thorndike (1955) considered an item with a validity Co.-efficient as high as 0.25 as an outstanding "valid"
item. Hence those items were selected for the final draft which were having internal consistency of 0.20 and higher.

**Table 3.7**

**Discriminating Power of items of the second draft of Achievement Test**

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>D.P.</th>
<th>No. of Items</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.40 and above</td>
<td>39</td>
<td>Accepted</td>
</tr>
<tr>
<td>2</td>
<td>.20 to .39</td>
<td>53</td>
<td>Modified and Accepted</td>
</tr>
<tr>
<td>3</td>
<td>Below .20</td>
<td>47</td>
<td>Rejected</td>
</tr>
<tr>
<td>4</td>
<td>Negative value</td>
<td>9</td>
<td>Rejected</td>
</tr>
</tbody>
</table>

A bivariate scatter diagram of achievement test was prepared placing each item in the appropriate column and row according to the range of difficulty value and discrimination index respectively. Thus, 92 items were retained in the final form of the test. The bivariate scatter diagram is given in Appendix-B.

(f) Standardization of Achievement Test:-

92 items constituted the final form of the achievement test. The achievement test was further standardized by experimental validation of the test which included establishing reliability and validity.

(i) **RELIABILITY:-**
Reliability is one of the most important characteristics of a measuring tool. Reliability refers to the consistency of test scores. A reliable test is one that yield the same results again and again. The reliability was found by the split half method (odd-even method) and the co-efficient of reliability was 0.97 which indicates that the test is highly reliable.

(ii) VALIDITY:-

Validity is the extent to which a test measures what it purports to measure. The validity of the achievement test constructed for the present study was taken for granted because this is in accordance with Guilford (1971) who says, "There are some measures whose validity is taken for granted, for example, achievement test scores."

Regarding the method of establishing the validity of test Mouley stated, "At the most elementary level, it is necessary for all the tests to have content validity i.e. each question must be related to the topic under investigation, there must be an adequate coverage of the overall topic, the question must be clear and unambiguous etc. A most adequate approach to validation consists of checking the agreement between the responses elicited by the question against the criterion"
The test was validated against the criterion of content validity. Content validity is concerned with the adequate sampling of a specified universe of the content. Thorndike (1975) maintain that problem of content validity is parallel to the problem of preparing a blue print for a test and then building a test to match the blue print. So the achievement test was found to possess content validity as there was correspondence between the table of specifications and test items.

(g) FINAL FORM OF THE TEST:

The final form of the Science achievement test consisted of 92 items.

The final test alongwith the scoring key is given in Appendix-C.

3.5.2 SELF CONCEPT QUESTIONNAIRE (SCQ) BY R.K. SARASWAT

Self-concept Questionnaire developed by R.K. Saraswat was used to measure the self-concept of pupils at pre-test stage and post-test stage. SCQ is a forty-eight item test, yielding scores in Six different dimensions of the self-concept and total self concept score. These dimensions are: Physical, Social, Temperamental, Educational, Moral and Intellectual
abilities. The statements of the test are simple and in declarative form. The pupils are expected to respond by marking a tick (✓) on any one of the five responses given against each item. A high score on the test indicates a high self-concept, while, a low score indicates a low self-concept. The test is given in Appendix - D.

The test-retest reliability of the test as mentioned by the author is .91 for the total self-concept measure. Reliability coefficients of its various dimensions varies from .67 to .88, which are given in table 3.8. This test is as mentioned in the manual have reasonable content validity.

Table –3.8

Test –Retest Reliability of the Self-Concept

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Self-Concept Dimension</th>
<th>No. of items</th>
<th>Reliability Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Physical</td>
<td>8</td>
<td>.77</td>
</tr>
<tr>
<td>B</td>
<td>Social</td>
<td>8</td>
<td>.83</td>
</tr>
<tr>
<td>C</td>
<td>Temperamental</td>
<td>8</td>
<td>.79</td>
</tr>
<tr>
<td>D</td>
<td>Educational</td>
<td>8</td>
<td>.88</td>
</tr>
<tr>
<td>E</td>
<td>Moral</td>
<td>8</td>
<td>.67</td>
</tr>
<tr>
<td>F</td>
<td>Intellectual</td>
<td>8</td>
<td>.79</td>
</tr>
<tr>
<td></td>
<td>Total self-concept</td>
<td>48</td>
<td>.91</td>
</tr>
</tbody>
</table>

For the administration of the test, booklets containing test items were distributed to the sample students individually. The instruction mentioned in the manual were strictly followed. Though no time-limit was set, the pupils were advised to
complete the test as quickly as possible. Generally the pupils took approximately 20 minutes to complete the test. The scoring was done with the help of scoring key.

3.5.3 **VERBAL TEST OF CREATIVE THINKING:**

Verbal test of creative thinking developed by Prof. Baqer mehdi was used to measure the verbal Creativity of the pupils. This verbal test measures the commonly identified Creativity factors like fluency, flexibility, originality.

(i) Fluency of thinking, which has to do with fertility of ideas.

(ii) Flexibility of thinking consisting of two factors, namely spontaneous flexibility (defined as "the ability or disposition to produce a great variety of ideas, with freedom from preservation") and adaptive flexibility which facilitates the production of a most unusual type of solution.

(iii) Originality, indicated by unusualness of responses, clever responses or remote associations and relationships, one must get away from the obvious, the ordinary, or conventional in order to make a good score.

Verbal Creativity of pupils was measured by the investigator using three dimensions namely fluency, flexibility and Originality.
Coefficient of reliability determined by test-retest method are 0.945, 0.921, 0.896 and 0.959 in respect of fluency, flexibility, Originality and total Creativity score. The validity coefficients against the teacher rating for each factor are 0.40, 0.32, 0.33 and 0.39 in respect of fluency, flexibility, originality and total Creativity score.

The test was administered by distributing the booklets of verbal tests to the students. The examinees were asked to carefully read the instructions and examples given on the front page before starting any activity. There were four sub-tests of verbal test of Creativity, namely, consequences test, unusual uses test, similarity test and product improvement test. The total time required for administering the test was 48 minutes in addition to the time necessary for giving instructions, passing out test booklets to pupils and collecting them back. The test was scored with the help of scoring guide.

3.5.4 SOcio- Economic Status Scale:-

The urban form of the socio-economic Status Scale by Kuppuswamy was used to determine the socio-economic status of students. The scale was primarily standardized for use in socio-economic investigations in urban parts of India. The scale measures three important variables contributing to the
socio-economic status in urban areas. These variables are education, occupation and income. Each variable is measured on a seven point scale.

Form B of the scale was used to measure socio-economic status of students. Form B of the scale is meant for students and it provides the information regarding their parents and guardians. This information was summarised in the score-card. (Form B of the scale and score-card are provided in appendix F). The appropriate weightage scores given against the items were encircled for each category. The scores were then entered in the last column. The scores of all the three variables were added in order to get the final score for socio-economic status.

3.5.5 CATTELL’S CULTURE FAIR TEST:-

Cattell’s Culture Fair Test of mental abilities was used to measure intelligence of pupils. It is a non-verbal intelligence test and is free from the influence of verbal fluency, cultural climate and educational level. The test can be administered individually or in a group, and requires the examinees to be able to perceive relationship in shapes and figures.

There are three scales in the Culture Fair Series. For the purpose of the present study, Scale-2 has been used which
consists of four Sub-tests. In the first Sub-test, an individual is presented with incomplete and progressive series. His task is to select, from among the choices provided, the answer which best continues the series. Second sub-test is related to classification. The individual is presented with five figures. He is required to select one which is different from the other four. The third sub-test is related to matrices and the individual is required to correctly complete the design or matrix presented at the left of each row. The fourth sub-test, relates to conditions or Topology and the individual is required to select, the one out of five choices which duplicates the conditions given in the far left box. Before each sub-test, examples are given so that the task requirements are clear to the examinee. The test is given in Appendix G.

The reliability of the test (Scale-2, From-A) as mentioned in the manual by Spearman-Brown formula is 0.79 and K-R Formula 21 is 0.81. Direct concept validity of the test is 0.85.

For administering the test, test booklets and answer sheets were distributed to the pupils. The pupils were instructed to fill in the information given at the top of the answer-sheet. Afterward all the necessary instructions were given to the students verbally. Time limit as mentioned in the
manual was strictly adhered to. Answer sheets were scored with the help of scoring keys. Raw scores obtained were converted into normalised IQ scores using Table-2 provided in the manual for scales 2 and 3.

3.6.0 DEVELOPMENT OF EXPERIMENTAL MATERIAL FOR EXPERIMENTAL GROUP-1

Six units of VII class Science syllabus prescribed by Central Board of School Education Constituted the course content covered in the experiment.

The concepts underlying six units to be covered in the experiment, were thoroughly reviewed and outlines of all the lessons were constructed. The list of questions provided at the end of unit in the text-book was supplemented by developing additional objective type/short answer type questions.

Three forms of mastery tests for each of the six units were constructed. These tests are an integral and essential part of mastery learning model as they enable the teacher to find out whether the learner has attained the mastery level at the completion of each unit or not. It helps in diagnosing the student's difficulties and thus, in providing remedial measures appropriate to the needs of the student during the course of
experiment. The steps followed in constructing the formative/mastery tests were:-

(1) **DECIDING THE SUBJECT AND UNITS:**

Subject field identified for the purpose of experiment was Science. Science subject was chosen because the investigator was teaching Science in the school where the experiment was conducted. Six units were selected to teach during the experiment. The criteria for selection of the units was that these were not taught to the class by the concerned Science teacher. Thus, following units were selected for the experiment:

(i) Electric charges at rest.
(ii) Energy.
(iii) Life processes
(iv) Air
(v) Water
(vi) Sound

(2) **CONTENT ANALYSIS:**

A content analysis of learning units into subunits and components was made. Content was defined in terms, facts, rules, principles and skills. The content covered the material which had not been introduced to the students in prior
learning units. Then a list of identified elements of new content was prepared.

(3) FORMULATION OF SPECIFIC OBJECTIVES:-

Specific objectives in terms of behavioural outcomes of students were formulated. While formulating these objectives, it was kept in mind that all the contents to be covered were taken view of in the experiment.

(4) CONSTRUCTION OF TESTS:-

Three parallel forms of the formative tests of objective types were developed on the basis of the contents and the specific objectives formulated earlier. Scoring key was also prepared for each of the three tests.

(5) EXTERNAL REVIEW:-

The three forms of tests, were shown to five experienced teachers teaching Science to Class VII. Only those questions were selected for final tests which have 80% unanimity. This was done in order to detect language inadequacy and eliminate flaws, if any.

(6) INTERNAL REVIEW:-

The tests were subjected to internal review to ensure that all the questions in the three forms of the formative
tests were in consonance with the specific objectives besides checking out curricular deficiencies.

(7) **FIELD TRIAL:**

The three forms of the formative tests were tried out on a small sample of 15 students. The tests were administered by the researcher herself so that any difficulty relating to the tests could be treated/solved.

(8) **FINAL INTERNAL REVIEW:**

After field trial the tests were finally reviewed in which some items were dropped whereas, others were modified.

(9) **LESSON PLAN OF MASTERY LEARNING MODEL IS GIVEN IN APPENDIX- (H)**

3.6.1 **DEVELOPMENT OF EXPERIMENTAL MATERIAL FOR EXPERIMENTAL GROUP-II**

The experimental group-II was taught through Inquiry training model. For teaching this group, the investigator took training in the use of inquiry training model from the supervisor. The investigator prepared lesson plans in Science (Appendix-I ) for the Inquiry training model. These lesson plans were discussed with the supervisor and educationists and
were practiced by the investigator under simulated conditions using Inquiry training model.

3.7.0 EXPERIMENTAL PROCEDURE:-

It consisted of three stages:-

(i) Pre-testing, (ii) Experimental Treatment and (iii) Post-testing

3.7.1 PRE-TESTING:-

Before the start of the experiment, the sample subjects were interacted and rapport established with them. They were oriented to the tests to be used with them and also the methodology of the treatment, viz the mastery learning model and inquiry training model. Five pre-tests i.e. S.E.S, Intelligence, Self-Concept, Achievement and Creativity were administered to the students of three groups, by the researcher herself. Co-operation of the class teacher was sought for administering the tests properly. The instructions pertaining to the tests were explained verbally in clear terms to the students before administering the test. All the three groups were administered these tests one by one. The administration of these tests was carried out as per norms and instructions contained in their manuals. The pre-testing programme is given in Table 3.9.
Table 3.9

Programme of Pre-testing

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Date</th>
<th>Tests administered in Control Group</th>
<th>Tests administered in Experimental Group I</th>
<th>Tests administered in Experimental Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30.7.98</td>
<td>Socio-economic Status Scale</td>
<td>Socio-economic Status Scale</td>
<td>Socio-economic Status Scale</td>
</tr>
<tr>
<td>2</td>
<td>5.8.98</td>
<td>Intelligence test</td>
<td>Intelligence test</td>
<td>Intelligence test</td>
</tr>
<tr>
<td>3</td>
<td>10.8.98</td>
<td>Achievement test</td>
<td>Achievement test</td>
<td>Achievement test</td>
</tr>
<tr>
<td>4</td>
<td>11.8.98</td>
<td>Self-Concept test</td>
<td>Self-Concept test</td>
<td>Self-Concept test</td>
</tr>
<tr>
<td>5</td>
<td>12.8.98</td>
<td>Creativity test</td>
<td>Creativity test</td>
<td>Creativity test</td>
</tr>
</tbody>
</table>

3.7.2 EXPERIMENTAL TREATMENT:-

To determine the effectiveness of independent variables, the experimental variables were manipulated in the form of teaching based on mastery learning and inquiry training model on Class VII students. All the three groups viz control group, experimental group I and experimental group II were taught by the investigator herself so as to avoid teacher variable and maximize precision. The control group was taught through conventional method of teaching, while the experimental group I was taught using Mastery Learning Model and the experimental group II was taught through Inquiry training model. Same topics were taught to three groups in 12 weeks.
periods of 40 minutes. Structured lesson plans were prepared for mastery learning strategies and inquiry training model.

(a) Teaching of Experimental Group I:-

This group was exposed through mastery learning model. The criteria decided for mastery of the content was 80 to 90% mastery of the content by 80 to 90% of the students. The procedure consisted of the following steps:-

(i) INFORMING THE PUPILS ABOUT THE INSTRUCTIONAL OBJECTIVES:-

Students were apprised about the units to be covered during the experiment. They were also familiarized about the sequence of teaching the selected units. The concepts, rules and processes involved in the content were specifically made explicit to the students alongwith instructional objectives. They were apprised about the mastery level decided.

(ii) ASSESSMENT FOR PRE-REQUISITES:-

An objective type test was administered to assess the pre-requisites of first unit. The students identified as deficient in necessary pre-requisites were provided the help according to their need. It was done to ensure that all the
students were equipped with the necessary pre-requisites before starting the teaching of first unit.

(iii) **TEACHING THE LEARNING TASK TO THE CLASS AS A WHOLE:-**

First unit was taught to the whole class employing the usual techniques of teaching with a view to bringing the maximum number of students to the level of maximum learning.

(iv) **UNIT FORMATIVE TEST-I:-**

After presenting the learning task, mastery level of the pupils was assessed by administering the formative test I. It was done with a view to classify the pupils in groups according to their levels of learning. Pupils who scored 90 percent or above were placed in the mastery group, while rest of the pupils were placed in the non-mastery group.

(v) **DIFFERENTIAL TEACHING SESSIONS:-**

Non mastery group was further divided into subgroups on the basis of their attainment. Students approximating the mastery level i.e., getting 80% or above but less than 90% required a little more self practice which they did themselves with additional materials related to the learning task to achieve mastery level. Student scoring 60% or above but below 80% were divided into smaller groups. They were
assisted by the pupils of mastery group. Students getting 20% or above but less than 60% were taught individually by peers of mastery group. The remaining group of students consisting of those who scored less than 20% were intensively taught by the teacher herself. In the light of the formative test-I, the teacher provided guidelines to the peers about how to assist pupils under their care. The teacher also appraised the students about their respective strength and weakness as shown by their performance in the formative test I. They were suggested necessary corrective measures.

(vi) **FORMATIVE TEST-II:-**

In the Second phase the pupils were administered formative test-II. On the basis of performance, the students were again divided into mastery and non-mastery groups. The criteria for forming the groups was same as described earlier. It was found that the number of students achieving mastery level had increased. Performance in formative test II was utilised to plan further strategies in order improve the learning level of non-mastery group of students to the mastery level.

(vii) **INTENSIVE TEACHING SESSION:-**

As a result of differential teaching session the number of students in non-mastery group were smaller than
before. These students were again assisted using both peer-tutoring by mastery level students techniques and teacher-tutoring. Additional instructional material was also used in this process. The students in the lowest range of scores were given instructions personally by the teacher. In addition drill and practice techniques were used to improve their learning.

(viii) FORMATIVE TEST-III:-

After the completing of intensive teaching session formative test III was administered to the students. Results revealed that a 80% of students were able to acquire the decided mastery level. The rest of the students who were unable to achieve mastery level were helped by the teacher herself. A few of them were also helped by the parents following the guidelines provided by the teacher.

(ix) TEACHING THE NEXT UNIT:-

The procedure and steps used in teaching unit-I were followed in teaching the next unit. Subsequently all the six units selected for teaching during the experiment were taught in a similar manner.

(b) TEACHING TO EXPERIMENTAL GROUP-II:-

Inquiry training model by Suchman(1962) was followed to provide instructions to the experimental group II.
Discrepant events were prepared on the same content which was taught to the control group and experimental group-I. For teaching the experimental group-II through Inquiry training model, a lesson plan for each unit was prepared. While preparing for teaching, the five phases of the Inquiry training model were followed. Syntax of the inquiry training model has been given in table 3.10.

Table 3.10
SYNTAX OF THE INQUIRY TRAINING MODEL

<table>
<thead>
<tr>
<th>Phase one: Confrontation With the problem</th>
<th>Phase Two: Data Gathering – Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explain inquiry procedure</td>
<td>Verify the nature of objects and conditions.</td>
</tr>
<tr>
<td>Present discrepant event</td>
<td>Verify the occurrence of the Problem situation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase Three: Data Gathering – Experimentation</th>
<th>Phase Four: Organizing Formulating an explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolate relevant variables</td>
<td>Formulate rules or explanations.</td>
</tr>
<tr>
<td>Hypothesize (and test) causal relationships.</td>
<td></td>
</tr>
</tbody>
</table>

Phase Five: Analysis of the Inquiry process

Analyze inquiry strategy and develop more effective ones.

Phase one, requires that the teacher present the problematic situation and explain the inquiry procedures to be followed to the students (the objectives and the procedure of
the Yes/No questions). It is followed by the formulation of a discrepant event in the form of the problem taken in the lesson plans.

Phase two, verification, is the process whereby students gather information about an event they see or experience in experimentation.

Phase three, students introduce new elements into the situation to see if the event happens differently. Although verification and experimentation are described as separate phases of the model, the students thinking and the types of questions they generate usually alternate between these two aspects of data gathering.

Experiment serve two functions:-

Exploration and Direct testing.

Exploration-changing things to see what will happen is not necessarily guided by a theory or hypothesis, but it may suggest ideas for a theory.

Direct testing occurs when students try out a theory or hypothesis. The process of converting a hypothesis into an experiment is not easy and takes practice. Many verification and experimentation questions are required just to investigate,
one theory. We have found that even sophisticated adults find it easier to say, "I think it has something to do with ...................................." than to think of a series of questions that will test the theory. Also, few theories can be discarded on the basis of one experiment. Although it is tempting to throw away a variable if the first experiment does not support it, it can be very misleading to do so.

One of the teacher's role is to restrain students whenever they assume that a variable has been disprove when it has not.

A Second function of the teacher is to broaden the student's inquiry by expanding the type of information they obtain. During verification they may ask questions about objects, properties, conditions, and events. Object questions are intended to determine the nature or identity of objects. (Is a Knifé made of steel? Is the liquid water). Event questions attempt to verify the occurrence or nature of an action. Condition questions relate to the state of objects or systems at a particular time. Property questions aim to verify the behaviour of objects under certain conditions as a way of gaining new information to help build a theory. Because students tend not to verify all aspects of the problem, teachers
can be aware of the type of information needed and work to change the questioning pattern.

In phase Four, the teacher calls on the students to organise the data and to formulate an explanation. Some students have difficulty in making the intellectual leap between comprehending the information they have gathered and constructing a clear explanation of it. They may give inadequate explanations, omitting essential details. Sometimes several theories or explanations are possible based on the same data. In such cases, it is often useful to ask students to state their explanations so that the range of possible hypothesis becomes obvious. Together the group can shape the explanation that fully responds to the problem situation.

Finally in Phase Five, the students are asked to analyse their pattern of inquiry. They may determine the questions that were most effective, the lines of questioning that were productive and those that were not or the type of information they needed and did not obtain. This phase is essential if we are to make the inquiry process a conscious one and the systematically try to improve it.
The model promotes strategies of inquiry and the values and attitudes that are essential to an inquiring mind, including:

- Process skills (observing, collecting, organizing data, identifying and controlling variables; formulating and testing hypotheses and explanations inferring).
- Active, autonomous learning, verbal expressiveness.
- Tolerance of ambiguity, persistence, logical thinking.
- Attitude that all knowledge is tentative.
The chief learning outcomes of inquiry training are the processes involved such as observing, collecting and organising data, identifying and controlling variables, making and testing hypotheses, formulating explanations and drawing inferences. The model splendidly integrates these several process skills into a single, meaningful unit of experience.

The format of the model promotes active, autonomous learning as the students formulate questions and test ideas. It take courage to ask question but is hoped that this type of risk will become second nature to the students. They will also become more proficient in verbal expression as well as in listening to others and remembering what has been said. Although its emphasis is on process, inquiry training also results in the learning of content in any curriculum area from which problems are selected.

3.7.3 POST-TESTING:

The completion of the teaching of contents to both the groups was followed by post-testing. The following tests were administered in both the groups. The programme of post-testing is summarised in Table 3.11.
Table 3.11

PROGRAMME OF POST-TESTING

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Date</th>
<th>Test administered to Control Group</th>
<th>Test administered to Experimental Group I</th>
<th>Test administered to Experimental Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>27.11.98</td>
<td>Achievement test</td>
<td>Achievement test</td>
<td>Achievement test</td>
</tr>
<tr>
<td>2.</td>
<td>28.11.98</td>
<td>Self-Concept test</td>
<td>Self-Concept test</td>
<td>Self-Concept test</td>
</tr>
<tr>
<td>3.</td>
<td>29.11.98</td>
<td>Creativity test</td>
<td>Creativity test</td>
<td>Creativity test</td>
</tr>
</tbody>
</table>

3.8.0 SCORING

Responses of each pupil on S.E.S, Intelligence Test, Achievement Test, Creativity Test and Self-concept Test were scored using the prescribed scoring keys and the key prepared by the investigator. These scores were then tabulated and subjected to statistical analysis.

3.9.0 STATISTICAL ANALYSIS:-

To achieve objectives of the study, the data collected was statistically analysed using the following techniques:-

1. The raw scores were tabulated separately into frequency distribution.

2. Descriptive statistics such as means and S.D.'s were worked out on the scores of achievement, self concept and creativity.

120
3. Analysis of variance (ANOVA) was used on pre-test, post-test and gain scores of achievement test in Science, self-concept and Creativity.

4. 't' test was employed for testing the significance of difference between the means of pupils achievement in Science, their self-concept and Creativity on post test and gain scores. The value of 't' was computed with the help of the following formula:-

\[
t = \frac{M_1 - M_2}{\sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}}
\]

Where  
\[M_1 = \text{Mean of first group;}
\]
\[M_2 = \text{Mean of second group;}
\]
\[\sigma_1 = \text{Variance of first group;}
\]
\[\sigma_2 = \text{Variance of second group;}
\]
\[N_1 = \text{Number of cases in first group}
\]
\[N_2 = \text{Number of cases in second group}
\]

To test the significance of 't' values, the following levels of confidence were established.

0.05 Level of Confidence

0.01 Level of Confidence

Mean scores in respect of achievement in Science, self-concept and creativity were pictorially presented in the form of
histograms. Histograms were drawn in respect of pre-test, post-test and gain scores of experimental group I, experimental group II and control group.