CHAPTER III

DESIGN OF THE STUDY

The present chapter deals with the design of study. It describes sample, variables to be studied, tools, experimental design, procedure and statistical techniques used for the analysis of data.

3.1 Sample

Keeping in view the design of the experiment, multi-stage random sampling technique was employed to raise the sample. A sample of 260 students of IX class was taken.

Four schools were randomly selected out of recognised and aided high schools of Ludhiana city. 65 students were taken randomly from each school. In order to minimise interaction between the subjects of two groups, it was decided that students of a school should be assigned to one group i.e. one treatment only. To achieve this end, out of 4 schools, two schools were randomly assigned to group $G_1$ and two schools to group $G_2$. Those students who did not attend regularly were dropped later on. So 240 students were taken for analysis of data. School-wise break up of the sample is given in Table 3.1.
Table 3.1
School-wise break up of the sample

<table>
<thead>
<tr>
<th>Sr.no.</th>
<th>Name of the school</th>
<th>Total no. of students in IX class</th>
<th>No. of students selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Govt. Senior Model High School, P.A.U., Ludhiana</td>
<td>130</td>
<td>65</td>
</tr>
<tr>
<td>2</td>
<td>Govt. Senior Model High School, Cymetry Road, Ludhiana</td>
<td>92</td>
<td>65</td>
</tr>
<tr>
<td>3</td>
<td>R.S. Model High School, Model Town, Ludhiana</td>
<td>83</td>
<td>65</td>
</tr>
<tr>
<td>4</td>
<td>New Model High School, Sarabha Nagar, Ludhiana</td>
<td>70</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>375</td>
<td>260</td>
</tr>
</tbody>
</table>

3.2 Variables

In all seven variables were included in the study. Independent variables included two treatment and three classifying variables whereas dependent variables were two.

**Independent Variables**

The following variables were taken as independent variables.

**1. Treatment Variables** involved two training strategies:

(i) Training strategy to develop right brain i.e. divergent thinking (A₁).

(ii) Training strategy to develop left brain i.e. convergent thinking (A₂).
2. Classifying Variables

(i) Intelligence (High/low)

(ii) Personality types (Extravert/Introvert)

(iii) Cognitive style (Field independent/Field dependent)

Dependent/Criterion Variables

(i) Cerebral Dominance
   
   (a) Whole Brain (W)
   
   (b) Left Brain (L)
   
   (c) Right Brain (R)

(ii) Creative Problem-Solving Skills in Mathematics
   
   (a) Fluency (F)
   
   (b) Flexibility (X)
   
   (c) Originality (O)
   
   (d) Total scores on creative-problem-solving skills.

3.3 Tools

The following tools were used in the study:

1. Training strategies: $A_1$ - strategy to train right hemisphere
   
   $A_2$ - Strategy to train left hemisphere

2. Achievement Test to measure Creative Problem-Solving Skills in Mathematics (developed by the investigator for local use).

3. Torrance’s Test of Style of Learning and Thinking, SOLAT (1988) to identify cerebral dominance.

5. Eysenck’s Maudsley Personality Inventory (Hindi version) by Jalota and Kapoor (1966).

6. Group Embedded Figures Test by Witkin et al. (1971) to measure field-independence and field-dependence.

3.4 Description of Tools

3.4.1 Training Strategies

Strategy A1: The strategy was designed to train right hemisphere i.e. to inculcate divergent thinking or creative problem-solving skills. It involved the following steps:

1. Presentation of the Problem

The problems or tasks were presented to the students one by one. After they familiarized themselves with the problem, they were asked to give as many solutions to the problem as they could. Each solution should be different, novel or unusual.

2. Involvement or Struggle

Enough time was given to students for involvement in finding solutions to the problem. There was frustration among students when they could find no solution or multiple solutions to the given problem.

3. Hints or Cues

A small cue or hint was given to students and again they were asked to involve in solving the problem. Still, if they could not solve it in different ways, they were asked to solve it at home.

4. Presentation of New Task and Refreshing the Old

New task was presented on the following day. A few minutes everyday were also devoted to refresh the students' interest in the problems not solved.
and to find more and more solutions. This renewed and increased their involvement in solving the problems.

Then any time during the training students were asked to jot down the new solutions they got to the previous ones.

This process continued till the end of training.

Strategy $A_2$

The strategy $A_2$ involved traditional method of solving problems, that is, training of left hemisphere. The tasks were presented to the students one by one. If they could not solve the problems, the solution was given to them, but they were not encouraged to give all different possible solutions.

Tasks Used for Training

Same tasks were used by the investigator to train right as well as left hemisphere (Appendix - ii). Tasks consisted of four mathematical components. A brief description of types of tasks is given below:

(a) Computational Tasks

Consisting of numerical operations as addition, subtraction, division, multiplication and manipulation of numerical quantities.

(b) Pattern Recognition Tasks

Tasks exhibiting pattern in numerical and spatial configurations, spatial arrangements.

(c) Logical Reasoning

The tasks which involve certain conditions that lead to universally acceptable conclusions.
(d) Symbolic Manipulation

The tasks consisting of quantities expressed in symbolic or numerical form which could be manipulated in symbolic entities irrespective of the substance, if any.

3.4.2 Achievement Test in Creative Problem-Solving Skills in Mathematics

The achievement test in creative problem-solving skills in mathematics for IX class was developed by the investigator. The final draft of the test included 14 items. The items can be resolved into four distinct, but not discreet components: computational operations, pattern recognition, logical reasoning and symbolic manipulation.

The test was divided into two parts:

Part I consists of 3 items and time allowed was 15 minutes. This part tested only the fluency aspect of creativity.

Part II consists of 11 items which tested fluency, flexibility and originality. The time allowed was 45 minutes. Thus the whole test took one hour for completion.

The test was recorded for fluency, flexibility, originality and creative problem-solving skill totals.

The reliability of the test calculated by test-retest method came out to be 0.954, 0.899, 0.888 and 0.957 for fluency, flexibility, originality and creative problem-solving skill totals respectively. It was validated for its content only. The final draft of the test has been given in Appendix - i.
3.4.3 Style of Learning and Thinking - SOLAT (Youth Form) by E.P. Torrance (1988)

E.P. Torrance constructed this test assisted by McCarthy and Kolesinki. SOLAT indicates a student's learning strategy and brain hemisphere preference in problem solving. The youth form is intended for grades 6 to 12 and can be administered in classroom groups. The working time of the test is 30-40 minutes. Youth form of the test consists of 28 items and has a simple response format. For each item, there are two statements and there are four ways to respond.

1. Check the first statement if it describes you.
2. Check the second statement if it describes you.
3. Check both statements if you are good at both or enjoy both, and if you do not have a strong preference for one over the other.
4. Check neither statement if you are not good at either or if you enjoy neither.

Students record their responses in the blanks at the left on the test sheet. A hand made scoring key was prepared to score the test items. Raw scores were recorded for W (whole brain), L (left brain) and R (right brain). These scores were converted into standard scores according to tables given in the manual.

Product-moment reliability coefficients by test-retest method have been reported to be 0.47 (whole brain), 0.57 (right brain) and 0.73 (left brain).
3.4.4 Hundal's General Mental Ability Test (1962)

This test was used to measure the verbal intelligence of students. This test is in Panjabi and is suitable to the population. This is a composite test consisting of 100 items pertaining to seven sub-categories - number series, analogies, classifications, inferences, discrimination, opposites and synonyms. Most of the test items are multiple-choice type arranged in the order of increasing difficulty. The subjects are required to write correct response on the response sheet provided to them. The time-limit for this test was 20 minutes.

The test-retest reliability of the test is 0.991 and odd-even reliability is 0.87. Validity of the test has been reported to be 0.690.

The test was administered strictly in accordance with the instructions given in the manual. A hand made scoring key was prepared to score the test items. The raw scores were used to classify the sample into high intelligent and low intelligent subjects. The groups were formed by using the median of the intelligence scores.

3.4.5 Eysenck's Maudsley Personality Inventory Hindi Version by Jalota and Kapoor (1966)

Hindi version of Eysenck's Maudsley Personality Inventory (M.P.I) by Jalota and Kapoor was used to measure personality types. It is a brief, standard, easily administrable and scorable inventory which is designed for assessing neuroticism-stability and introversion extraversion dimensions of personality. Although no time limit is enforced in this test but it takes 15 to 20 minutes to complete long scale and 3 to 5 minutes for short scale.
Each of the question is to be answered with 'Yes', ?, 'No'. This test can be used on a group or individuals. The long scale of the test has been used in the present study. The reliability co-efficient, the mean combined score and standard deviations of long scale for extraversion were 0.42, 27.8 and 6.20. The test was conducted according to the instructions given in the manual of the test. A hand made scoring key (given in Appendix v) was prepared to score the test items. The raw scores itself were used to classify the subjects into extraverts and introverts based on the median of the sample.

3.4.6 Group Embedded Figures Test (GEFT)
by Witkin et al. (1971)

Witkin's Group Embedded Figures Test (GEFT) was used to assess broad dimensions of personal functioning that comes from cognitive style which included the characteristics, self consistent modes of functioning which individuals show in their perceptual and intellectual activities.

The GEFT contains three sections: the first section, which contains 7 very simple items, is primarily for practice and not included in scoring, the second and third sections, each of which contains 9 more difficult items. The time limit was 5 minutes each for the second and third sections. The scoring is done by the total number of simple forms correctly traced in the second and third sections combined. Omitted items are scored as incorrect. The test has a fairly high reliability of 0.82 as shown by the Spearman-Brown prophecy formula for both males and females. The raw scores were used to classify the students of each group into
two groups, that is, field independent and field-dependent groups. These
groups were formed by using the median of the scores obtained on GEFT.

3.5 Operational Definitions of the Terms Used in the Study

I. Strategies

Two training strategies were defined as follows:

Strategy A₁ : Which trains right hemisphere, i.e. inculeates divergent thinking.

Strategy A₂ : Which trains left hemisphere i.e. inculeates convergent thinking.

II Cerebral Dominance

Cerebral dominance means the scores obtained on the following dimensions as measured by SOLAT : (a) Whole brain (W): the number of times subjects checked 'L' and 'R'. (b) Left brain (L): the number of times subjects checked 'L', (c) Right brain (R): the number of times subjects checked 'R'.

III. Creative Problem-Solving Skills

Creative problem-solving skills were as measured by the achievement test (developed by the investigator) on the following dimensions:

(a) Fluency - scores obtained from the total number of solutions given to the problems.

(b) Flexibility - scores obtained for different categories of solutions to the problems.

(c) Originality - scores obtained for uncommon solutions given to the problems.

(d) Creative problem solving skill totals - total scores on fluency, flexibility and originality.
IV. Intelligence

As measured by Hundal's General Mental Ability test of verbal intelligence:

(a) High intelligent: Students having a score higher than 37.
(b) Low intelligent: Students having a score of 37 or less.

V. Personality types

As measured by Eysenck's M.P.I.

(a) Extraverts: Subjects who have a score of 27 or more.
(b) Introverts: Subjects having a score less than 27.

VI. Cognitive Style

As measured by Witkin's Group Embedded Figures Test.

(a) Field-independents: Subjects who have a score of 8 or more.
(b) Field-dependents: Subjects having a score less than 8.

3.6 Research Design

Present study was conducted through pre-test, post-test experimental design. Schematic layout of the design is given in Table 3.2.

3.7 Procedure

In Phase-I, Achievement Test in creative problem-solving skills in mathematics, Torrance's test: Style of Learning and Thinking, Hundal's General Mental Ability Test, Eysenck's M.P.I. and Witkin's Group Embedded Figures Test were given to the students of both groups.
### Table 3.2
Schematic layout of the design

| Phase-I  
| (Pre-test) | Group G₁  
| (N=130) | 
| (i) Achievement test in creative problem-solving skills in mathematics. | 
| (ii) Torrance’s Test: Style of Learning and Thinking (SOLAT) | 
| (iii) Hundal’s General Mental Ability Test for verbal intelligence | 
| (iv) Eysenck’s M.P.I. | 
| (v) Witkin’s Group Embedded Figures Test | 
| Phase-II  
| (Training stage) | Group G₂  
| (N=130) | 
| (i) The students were given training for six-weeks through strategy A₁. | 
| (ii) Torrance’s Test: Style of Learning and Thinking (SOLAT) | 
| Phase-III  
| (Post-test) | | 
| (i) Achievement test in creative problem-solving skills in mathematics. | 
| (ii) Torrance’s Test: Style of Learning and Thinking (SOLAT) | 

(i) Achievement test in creative problem-solving skills in mathematics.

(ii) Torrance’s Test: Style of Learning and Thinking (SOLAT)

(iii) Hundal’s General Mental Ability Test for verbal intelligence.

(iv) Eysenck’s M.P.I.

(v) Witkin’s Group Embedded Figures Test

(i) The students were given training for six-weeks through strategy A₂.

(ii) Torrance’s Test: Style of Learning and Thinking (SOLAT)
In Phase-II, both the groups were given training for 6 weeks. Group $G_1$ was given training through strategy $A_1$ and group $G_2$ through strategy $A_2$.

In Phase-III, after 6 weeks training, Torrance's Test of Style of Learning and Thinking and achievement test in creative problem-solving skills in mathematics were administered again to see the change.

3.8 Data Collection

By following the above mentioned procedure for the conduct of experiment, the investigator collected the sampled data which comprised the following sets of scores:

I. Achievement scores in creative problem-solving skills in mathematics on the following dimensions:
   (a) Fluency (F)
   (b) Flexibility (X)
   (c) Originality (O)
   (d) Total scores on creative problem-solving skills were found by adding the scores on fluency, flexibility and originality.

II. Cerebral dominance scores in respect of:
   (a) Whole brain (W)
   (b) Left brain (L)
   (c) Right brain (R)

III. Intelligence scores

IV. Personality scores

V. Cognitive style scores
3.9 Statistical Analysis of Data

The data were analysed by computing mean, median and S.D. To test hypotheses four-way analysis of variance (2 x 2 x 2 x 2) and t-test were employed.