CHAPTER –IV

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CHAPTER IV

METHODOLOGY AND PROCEDURE

The focus of present investigation was to study and compare the effectiveness of MLM, CAM and traditional method of science teaching in relation to learner’s traits. Therefore, experimental method was used in this study. In this method the researcher has some degree of control over the variables involved and the conditions under which the variables are observed. The researcher deliberately manipulates some aspect of the experiment in which researcher is interested and observes how the things are affected or changed. Experimental method was chosen as it is the most suitable method for comparison of groups treated differently.

The experiment was conducted to ascertain the effectiveness of MLM, CAM and traditional method (TM). In this experiment the achievement in science was considered as the criterion variable. The learning through the different methods was the experimental variable. The three variables self-efficacy, persistence & study habits were independent variables. The sex was included as moderator variable. Intelligence was the controlled variable.

The sampling, description of tools, statistical techniques and experimental design has been discussed in this chapter.
DESIGN OF THE EXPERIMENT:

In the present study experimental method was used. The true experimental design provides full experimental control of variables. There are many experimental situations in which it is not possible for the researcher to assign subjects randomly to groups or exercise full control over the scheduling of experimental conditions. In such situations, the use of quasi experimental design is most suitable. It provides as much control as possible under existing conditions.

The problem under investigation was to study the effectiveness of concept attainment model, mastery learning model over traditional method of teaching science. For this the researcher had to frame three groups of subjects who were near identical in every respect.

The researcher tried to establish three groups that were similar as far as possible in respect of the variables that are related to achievement in science. For this the general intelligence was chosen as most affecting variable after the study of related literature. Experiment may be represented as:

SCHEMATIC REPRESENTATION OF THE EXPERIMENTAL DESIGN

<table>
<thead>
<tr>
<th>Phase</th>
<th>Experimental group I N=80</th>
<th>Experimental group II N=80</th>
<th>Control group III N=80</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Pre-test</td>
<td>for previous knowledge in science topics</td>
<td>intelligence test</td>
</tr>
<tr>
<td>II</td>
<td>Teaching through concept attainment Model (CAM)</td>
<td>Teaching through Mastery Learning Model (MLM)</td>
<td>Teaching through Traditional Method of Teaching (TM)</td>
</tr>
<tr>
<td>III</td>
<td>Post-test</td>
<td>for achievement in science topics</td>
<td></td>
</tr>
</tbody>
</table>
To control the situational variables constant the researcher treated all the available subjects in similar way except for their exposure to the treatment. In this study number of subjects was taken equal in each group. These groups were taught by the same teacher i.e. the researcher herself and in the same environmental conditions as far as possible.

In this study three treatments were to be compared in boys and girls both. So, their main effects and interaction effects were studied by using 3 x 2 factorial design. The pre-test scores (x) and post-test scores (y) of the subjects were taken up for analysis. The variable (x) was adjusted with the (y) variable. The techniques of ANOVA and ANACOVA were used to analyze the data.

Further, the three variables were taken up to evolve their role in different treatments. It was not feasible to take up all these variables simultaneously, So, it was decided to consider them separately. The high and low groups were identified on each factor by using John Kelley's dichotomy from boys and girls both. Thus 3 x 2 x 2 factorial design involving 12 cells was used for each characteristic. After identifying students in each cell of factorial design, their pre-test scores (x) and post-test scores (y) were used for the analysis. In this way the data were analyzed. The study was to be conducted on the basis of a sample.

**POPULATION AND SAMPLE:**

The present study was intended for secondary students. The students of IX class from C.B.S.E. Board were considered in the study.

The conclusions were formulated on the basis of a sample. So, it should be representative. The modules were prepared for IX class in science in English medium. So, experiment was to be conducted on IX class students from CBSE Board. Haldwani is one of important cities of Kumaun region. It has many institutions of English medium. In this
study the multi stage random sampling was used. First the researcher took a list of all English medium schools of CBSE Board in Haldwani from district education office. Three schools were chosen randomly. Three sections of boys and three sections of girls of IX class were chosen randomly. These sections were matched for the intelligence which is most important variable in academic performance as suggested by many research studies.

**TABLE 4.1**

**DISTRIBUTION OF SAMPLE ACCORDING TO INTELLIGENCE**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>School</th>
<th>Sex</th>
<th>Intelligence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>St. Paul School, Haldwani</td>
<td>boy</td>
<td>83.18, 11.12, 40</td>
</tr>
<tr>
<td>2.</td>
<td>Guru Teg Bahadur Public School, Haldwani</td>
<td>boy</td>
<td>81.65, 11.25, 40</td>
</tr>
<tr>
<td>3.</td>
<td>D.A.V. Public School, Haldwani</td>
<td>boy</td>
<td>85.90, 11.01, 40</td>
</tr>
<tr>
<td>4.</td>
<td>St. Paul School, Haldwani</td>
<td>girl</td>
<td>82.20, 13.41, 40</td>
</tr>
<tr>
<td>5.</td>
<td>Guru Teg Bahadur Public School, Haldwani</td>
<td>girl</td>
<td>85.82, 9.34, 40</td>
</tr>
<tr>
<td>6.</td>
<td>D.A.V. Public School, Haldwani</td>
<td>girl</td>
<td>85.60, 12.32, 40</td>
</tr>
</tbody>
</table>

Table 4.1 shows that each of the six sections were having 40 students and matched for intelligence. It was checked by applying F-test to the intelligence scores of the sections.
### Table 4.2
**Analysis of Variance for Intelligence Scores in Sections**

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section</td>
<td>5</td>
<td>756.93</td>
<td>151.38</td>
<td>1.15</td>
<td>.33</td>
</tr>
<tr>
<td>Error</td>
<td>234</td>
<td>30776.25</td>
<td>131.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>239</td>
<td>31533.18</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The non-significant value of F as shown in Table 4.2 denotes that six sections do not differ significantly on the intelligence scores. These sections may be regarded equivalent with regard to the intelligence. These sections were randomly assigned to different experimental conditions.

The age-wise description of sample is given in Table 4.3

### Table 4.3
**Structure of the Sample**

<table>
<thead>
<tr>
<th>Institutions</th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>St. Paul School, Haldwani</td>
<td>18</td>
<td>19</td>
<td>03</td>
</tr>
<tr>
<td>Guru Teg Bahadur Public School, Haldwani</td>
<td>14</td>
<td>25</td>
<td>01</td>
</tr>
<tr>
<td>D.A.V. Public School, Haldwani</td>
<td>16</td>
<td>23</td>
<td>01</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>67</td>
<td>05</td>
</tr>
</tbody>
</table>
Table 4.3 indicates that most of the students were of 14 & 15 years in age. The experiment was conducted on these groups. Further, for factorial design treatment, the stratification was done on the basis of learner's characteristics selected in the study. The data were collected from this sample by administering the research tools.

**THE TOOLS USED IN THE STUDY:**

In this investigation seven tools were used. A brief description of used tools has been provided below:

**THE PRE-TEST:**

This test was prepared by the investigator to check the fulfillment of necessary conditions and to assess their previous knowledge of the topic. It consists of 28 items. The description of the pre-test has been reported in the third chapter of the report. A copy of the pre-test along with the key has been provided in appendices C and D.

**THE POST-TEST:**

This test was prepared to measure the final performance. This test was constructed by the investigator herself. It consists of 28 items. The reliability and validity were estimated. The development of post-test has been reported in third chapter. A copy of post-test and its key have been provided in appendices E and F.

**MODULE ON CONCEPT ATTAINMENT MODEL:**

A module of concept attainment model was prepared on the topic of ‘work and energy’ by the investigator. It consisted of several units. The development of CAM module has been reported in third chapter. A copy of this has been provided in appendix A.
MODULE ON MASTERY LEARNING MODEL:

A module was prepared on the basis of mastery learning model by the investigator. The topic of ‘work and energy’ of IX class science was covered in this. The development of MLM module has been given in third chapter. A copy of this has been provided in appendix B.

SURVEY OF STUDY HABITS AND ATTITUDES:

The test "Survey of Study Habits and Attitudes" SSHA (Hindi version) was developed by Prof. M.C. Joshi and Dr. Jagdish Pandey in 1964. The questionnaire consists of 70 statements in first person about attitudes and habits of study. The statements cover the following areas: place of study, comprehension, taking down of notes, method of answering examination papers, amount of time for study, selection of subjects and preparedness etc. This test may be administered on a single individual or a group. It takes about 20-25 minutes in responding to all items but there is no time limit.

Some items are positively framed and some are negatively structured on a five-point rating continuum. The reliability of test is 0.89 which indicates high correlation between the obtained and true scores.

The content validity of the test item was made on a sample of 492 subjects where they were asked to rate the last item of the test “to my mind the question of this inventory are useless and cannot help anybody”. 8.5% of subjects rated it as almost never, rarely 1%, occasionally 3%, frequently 3% and almost always 2%. It suggested over-whelming majority of the subjects feel satisfied with the meaningfulness and comprehensiveness of test items.

The norms were established on an incidental sample of 475 adolescents of class X and XI with a mean age of nearly 17 years. In the
semi urban sample, the mean age-wise scores for subjects of similar age levels ranged between 30.30 to 32.40 and showed no significant difference among the groups.

The administration and scoring is quite easy. After the students have completed the response sheet, the answers are scored which can be done by machine or by two handmade stencils. The stencils are put on the answer sheet one after other and the right and elimination scores are obtained by counting the right marks (✓) made by subject visible through the holes irrespective of the column value. The total of these two scores yields the TSHA score of the subject.

This was considered a convenient and useful tool to assess study habits. The investigator used it in the present study. The response sheet of questionnaire has been provided in the Appendix J.

GENERAL SELF-EFFICACY SCALE:

General Self-Efficacy Scale in Hindi was developed by Dr. Shonali Sud from original German version in 2002. It is a self-administered scale which normally takes two to three minutes to complete.

There were 20 items in the original German version and only 10 items were retained after rated by expert bilinguals into "Good", "Better" and "Best". Finally those items rated as Best by majority were selected to constitute the final translated 10 item Hindi version of the Generalized Self-Efficacy Scale. It was then submitted to a sample of 398 undergraduates studying in colleges in Shimla, and item analysis was done which indicated that the $10^{th}$, $5^{th}$, $9^{th}$ and $4^{th}$ items completed very highly with the construct of self-efficacy, $r = 0.45, 0.43, 0.31$ and $0.30$ (P<0.001).
There are 10 statements & has a four choice response pattern ranging from 'Not at all true' which scores 1, 'some- what true' which scores 2, 'almost true' which scores 3 and 'exactly true' which scores '4'. Respondents are required to indicate the extent to which each statement applies to them. The scores of each of ten items are summed to give a total score. Thus the range of possible scores for this instrument could vary from a minimum score of 10 to a maximum of 40.

An item analysis was carried out by correlating responses to each item with total score. The coefficient of internal consistency, estimated by Croanbach’s alpha was determined to be 0.75. The mean, standard deviations and coefficient of correlations between the items and total scores were found to be 30.6, 4.57 and 0.75 respectively.

As suggested by the author for analysis the obtained raw score was converted into T-score on a mean of 50 and standard deviation of 10. Interpretations were done on the view that higher the score, the greater is individual's generalized sense of self-efficacy. The test was considered suitable for the study. Thus it was used. The response sheet of the questionnaire has been provided in the Appendix H.

PERSISTENCE QUESTIONNAIRE:

Persistence questionnaire was developed by Dr. Nisha Dhawan in 1982. On the basis of empirical and theoretical knowledge about persistence certain characteristics were identified and these were used for selecting items for the questionnaire. Using these behavioral characteristics as a guideline a large pool of items was prepared. Each item conveyed only a single idea and involved 'Yes' and 'No' type of responses. There are 20 items in the final persistence questionnaire.
Internal consistency was computed by correlating each scale item score with the total score on the selected 20 items. These correlations ranged from 0.46 to 0.56 with an average r value of 0.46 (N=240).

The split-half (odd-even) reliability coefficient of correlation was calculated for these 20 items. Using the Spearman Brown formula, an r value of 0.89 was obtained. The test-retest reliability obtained after a period of one month was 0.78.

The questionnaire was validated against a projective measure of persistence developed by the author. The correlation coefficient obtained between scores on the questionnaire and the projective test was found 0.46 (N=240). It indicated considerable validity for the measuring technique.

Each item is given a score of 1. Since there are 20 items the maximum score that can be obtained is 20 and the minimum score obtained is 0. All items checked as 'Yes' are given a score of 1 except on seven items (1,3,12,14,16,19 & 20) where 'No' is given a score of 1. An individual scoring on the upper end of the scale is more persistent than one scoring on the lower end. The questionnaire was administered on girls and boys of secondary students with age group of 15 years. T scores for the sample were prepared due to non availability of norms. The questionnaire is useful and can provide a reliable index of differences in persistence levels among individual. This test was considered appropriate to assess persistence level of the subjects in the study.

The response sheet of the questionnaire has been provided in the Appendix I.
CATTEL’S CULTURE FAIR INTELLIGENCE TEST:

Culture fair intelligence test was devised by Cattel to measure individual intelligence without the role of verbal fluency, cultural climate and educational level in 1949. Though the history of Culture faire scales began by Cattel in late 1920’s but it underwent many refinements in 1935, 1940 and 1949 etc. in form of difficulty level and sequencing of few items.

There are three scales. Scale 1 was designed for children 4-8 years of age, mentally handicapped and some adults. Scale 2 and 3 are wholly group administrable and is applicable for students of age 7½ years above and adults. Scale 2 and 3 tests are available in two forms A and B, the reason for the existence of two forms is mainly one of convenience. It may happen that due to shortage of time full test (A and B) could not be comfortably completed, so the two forms are administered after a brief rest one after the other to reduce fatigue. Of course, there will arise some circumstances which force the administrator to use Form A alone. For this appropriate norm tables and statistical information have been provided to guide the test administrator on these occasions.

The consistency over items of scale 2 Form A was found 0.76, over parts was 0.67 and over time was found to be 0.73 which are quite high.

The concept validity of scale 2 Form A was found to be 0.81 tested on a sample of 660 males and females. The concrete validity was calculated to be 0.70 on a sample of 523 males and females which included students and adults.

The Culture Fair Test can be administered to groups or individually. Answers can be marked in the test booklet or on separate
answer sheets. There are four sub-tests in Form A scale 2 i.e. 12 items of series, 14 items of classification, 12 items of matrices and 8 items of conditions. The time for the first sub-test is 3 minutes, for second 4 minutes, for the third is 3 minutes and for the fourth sub-test is 2½ minutes. Thus the total time to complete the test is 12½ minutes. Once the sub-tests have been administered, the raw scores are obtained by using a scoring key stencil. The stencil is put over the answer sheet properly as instructed and no. of correct mark (✓) are counted that lie under the holes in the stencil. The total right tick marks gives the raw score of the subject. Using Table 5.2 in the manual this raw score is converted into normalized, standard score I.Q. with a mean of 100 and standard deviation of 16, thus permitting direct comparisons with many other available intelligence measures. On the basis of standard scores interpretations were made. This test was considered useful in assessing general intelligence of students in the study. The response sheet of the test has been provided in the Appendix G.

STATISTICAL TECHNIQUES USED:

The main objective of this study was to compare the effectiveness of CAM, MLM over traditional method of teaching science in terms of pupils performance and then to investigate the effectiveness of these treatments in relation to selected learner’s characteristics. The effectiveness of treatments was also studied for boys and girls groups separately.

In educational researches mostly data are obtained on equal interval scale. Thus the parametric statistics is used for inferential purposes. In the present study the data were collected on equal interval scale. So, parametric methods were used.
The learning through modules may be influenced by previous knowledge of students in science. The Pre-test was constructed to know the previous knowledge of students. The scores of pre-test were considered as the potential for previous knowledge in the selected topic of science. It was desirable to adjust these pre-test scores with the post-test scores. The analysis of covariance technique was considered for this purpose.

The subjects were allocated to different cells, mentioned in the design of experiment. Their pre-test scores and post-test scores were taken up and analyzed by analysis of variance and covariance.

The interaction analysis was attempted for (Method x Sex); (Method x sex x self efficacy);(Method x Sex x persistence)and (Method x sex x study habits). Here, the analysis of variance of pre-test scores (x) was not done because in each case x scores were to be adjusted with post-test (y) scores. Where the number of subjects in the cells were unequal, the unweighted means analysis\(^1\) was done. \(F_y\) ratios were computed and analyzed. For analysis of covariance \(F_{y,x}\) ratios were computed & their significance was tested.

For two factors M&S, the 3x2 analysis of variance and covariance was done as shown in Table 4.4.

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### TABLE 4.4
ANALYSIS OF VARIANCE AND ANALYSIS OF COVARIANCE FOR (M x S)

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>ANOVA for Y scores</th>
<th>ANACOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>df</td>
<td>SS</td>
</tr>
<tr>
<td>M</td>
<td>2</td>
<td>M_y</td>
</tr>
<tr>
<td>S</td>
<td>1</td>
<td>S_y</td>
</tr>
<tr>
<td>M x S</td>
<td>2</td>
<td>M_S_y</td>
</tr>
<tr>
<td>Within Cells</td>
<td>N-6</td>
<td>W_y</td>
</tr>
<tr>
<td>Total</td>
<td>N-1</td>
<td></td>
</tr>
</tbody>
</table>

In above analysis M has three levels & S has two levels. N was number of total subjects. Thus, F_y and F_{y.x} ratios were computed. For three factors M, S & V, the 3 x 2 x 2 analysis of variance and analysis of covariance was done as shown in Table 4.5.

### TABLE 4.5
ANALYSIS OF VARIANCE AND ANALYSIS OF COVARIANCE FOR (M x S x V)

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>ANOVA for Y scores</th>
<th>ANACOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>df</td>
<td>SS</td>
</tr>
<tr>
<td>M</td>
<td>2</td>
<td>M_y</td>
</tr>
<tr>
<td>S</td>
<td>1</td>
<td>S_y</td>
</tr>
<tr>
<td>V</td>
<td>1</td>
<td>V_y</td>
</tr>
<tr>
<td>M x S</td>
<td>2</td>
<td>M_S_y</td>
</tr>
<tr>
<td>S x V</td>
<td>1</td>
<td>S_V_y</td>
</tr>
<tr>
<td>M x V</td>
<td>2</td>
<td>M_V_y</td>
</tr>
<tr>
<td>M x S x V</td>
<td>2</td>
<td>M_S_V_y</td>
</tr>
<tr>
<td>Within Cells</td>
<td>N-12</td>
<td>W_y</td>
</tr>
<tr>
<td>Total</td>
<td>N-1</td>
<td></td>
</tr>
</tbody>
</table>
In above analysis M has 3 levels, S & V have 2 levels each. N was total number of subjects. Thus, $F_y$ and $F_{y,x}$ ratios were computed.

To locate the actual difference among means of various cells, the F test was followed by the 't' test. The 't' values\(^2\) were calculated for the significance of differences between two means by the following formula:

$$t = \frac{M_1 - M_2}{SE_D}$$

- $M_1$ = Mean of first group
- $M_2$ = Mean of second group
- $SE_D$ = Standard Error of difference between means.

The mean of adjusted $y$ scores ($M_{y,x}$)\(^3\) was computed by:

$$M_{y,x} = M_y - b_w(M_x - GM_x)$$

Where,
- $M_x$ = mean of $x$ scores,
- $GM_x$ = general mean of $x$ scores
- $M_y$ = mean of $y$ scores,
- $b_w$ = regression coefficient within group

The $\chi^2$ test was also used for testing whether an obtained distribution of scores is normally distributed. The Chi-square test of goodness of fit was applied by computing the expected frequencies and observed frequencies. The discrepancy was computed for each class interval. The cell ratio was obtained by dividing squared cell discrepancies by the expected frequencies. The sum of these ratios provides the chi-square value. The following formula\(^4\) was used.

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e}$$

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\(^3\) ibid., p.302

\(^4\) ibid., p.253
Where, \( f_o \) = observed frequencies
\( f_e \) = expected frequencies

This \( \chi^2 \) test was used for testing the nature of distribution of study habit, self-efficacy and persistence scores.

The description of statistical techniques and design of experiment provided basic framework for analyzing data. The data collection has been reported in the following chapter.