CHAPTER – III
PLAN AND PROCEDURE

The present chapter attempts to elucidate the manner in which present study has been planned and conducted. This chapter indicates the line of approach of the study and consists of information related to the following aspects: research method and design, population and sample. Variables of the study, development of tools, procedure for data collection followed by method of data analysis.

3.1 RESEARCH METHOD AND DESIGN

3.1.1 Research Method

The investigator followed Experimental method for the study. Experimentation is the classic method of science laboratory where elements are manipulated and effects observed could be controlled. It is the most sophisticated, exacting and powerful method for discovering and developing an organized body of knowledge. Although the experimental method finds its great utility in the laboratory it has been effectively applied within non laboratory setting such as classroom where significant factors or variables can be controlled to some degree. The immediate purpose of experimentation is to predict events in the experimental setting. The ultimate purpose of this is to generalize the variable relationship so that they may be applied outside the laboratory to a wider population of interest. The experimenters manipulate certain stimuli and environmental condition to observe how the intervention has changed the behavior of the subjects. Their manipulation is deliberate and systemic. They must be aware of other factors that could influence the outcome and remove or control so that they can establish a logical association between manipulated factors and observed effects.
3.1.2 Research Design

The research design is basically a plan or blueprint to be followed while conducting the research and implementing a design consists of engaging a number of activities. The specific design used depends on the purposes and conditions of the research. According to Kerlinger (1964), a research design is the plan structure and strategies of investigation conceived so as to obtain answers to research question and control variance. The plan is the overall scheme of the research. It includes an outline of everything the investigator will do from writing the hypothesis and their operational implications to the final analysis of the data. The structure of the research is more specific. It is the outline, the scheme, the paradigm – of the operation of the variables. Strategy is more specific than plan. It includes the methods to be used to gather and analyse the data. In other words, strategy implies how the research objectives will be realised and how the problem encountered in the research will be tackled. In brief the research design does not tell us precisely what to do but rather tells the direction of observation making analysis. The quasi-experimental, pretest, post-test, follow-up test, control group experimental design was employed for the present study. The design was most appropriate since two intact classes were used and no randomization was done in the selection of subjects. As a rule, when any of the research procedures required in true experimental condition is absent, the design is best described as quasi – experimental design. A posttest parallel to the pretest was used to measure the achievement.

3.1.3 Identification of variables

The variables of study can be classified as listed below;

**Independent Variable**

- Learning strategy at two levels
  
a. Learning by conventional reading.
  
b. Learning by concept-mapping as a Follow-up strategy.
**Dependent Variables**

There are two dependent variables.

1. Achievement in chemistry.
2. Retention of learning.

**Intervening Variables and their control**

Concomitant variables or intervening variables are those variables which directly or indirectly affect the dependent variables.

1. Academic Environment to control this, the sample was selected only from one college of engineering affiliated to Maharishi Dayanand University, Rohtak, because the academic environment remains almost same within a college for all the students.

2. Physical Environment of the class: physical environment of the classroom remains same in the entire college.

3. Grade to be taught: the sample of the study included the students studying in I Semester of B.tech only.

4. Subject to be taught: Same topic in chemistry was taught to both groups.

5. Socio-Economic Status: as college is self financed college so most of the students belong to upper middle class/high income group families.

6. Instructor Behavior: the investigator conducted the experiment himself only. Selection of the study material, preparation of achievement test, employment of the treatments, was done only by the investigator herself. So the effect of inter-teacher variation was eliminated.

7. Maturation: subjects changes both biologically and psychologically in many ways over a period of time and those changes affect the dependent variables under consideration. To control this, the experiment was conducted in the beginning of the session and was finished in 28 days.
8. Prior knowledge of the subject: the achievement test as a pretest was administered to know the prior knowledge of the students in the concerned area.

9. Contamination effect: to control the contamination effect the students of control and experimental group were instructed separately. The students were not allowed to carry the reading material along with them.

10. Testing: the process of pre-testing at the beginning of an experiment can produce a change in the subjects. To control this, the parallel forms of achievement tests were used as a pre-test and post-test.

Table 3.1
Intervening and Extraneous Variables

<table>
<thead>
<tr>
<th>S.No</th>
<th>Intervening &amp; Extraneous Variables</th>
<th>Control employed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Academic environment</td>
<td>Remains same as all students are of same institute</td>
</tr>
<tr>
<td>2</td>
<td>Physical environment</td>
<td>Remains same as whole of experiment conducted at same institute</td>
</tr>
<tr>
<td>3</td>
<td>Grade to be taught</td>
<td>I-semester of B.tech.</td>
</tr>
<tr>
<td>4</td>
<td>Subject</td>
<td>Same subject used for both groups.</td>
</tr>
<tr>
<td>5</td>
<td>Socioeconomic status</td>
<td>Self financing college taken for study.</td>
</tr>
<tr>
<td>6</td>
<td>Instructor behavior</td>
<td>Investigator conducted study herself.</td>
</tr>
<tr>
<td>7</td>
<td>Maturation</td>
<td>Study conducted within short time of days.</td>
</tr>
<tr>
<td>8</td>
<td>Prior knowledge of subject</td>
<td>The topics selected were from their syllabus so it was assumed that all students possess some prior knowledge</td>
</tr>
<tr>
<td>9</td>
<td>Contamination effect</td>
<td>Students were not given material for home.</td>
</tr>
<tr>
<td>10</td>
<td>Testing</td>
<td>Same tools used for all students by the investigator.</td>
</tr>
</tbody>
</table>
3.2 POPULATION AND SAMPLE

The term population refers to describe group of individual, events or observations in which the researcher is interested. In the present study the population refers to students studying in I-semester of engineering colleges affiliated to Maharishi Dayanand University. A purposive sampling technique was used to select the sample of present study which comprised of 60 students of engineering I-semester and studying in Aravali college of engineering and technology of Faridabad. Initially the two intact groups of 35 students were taken as control and experimental and the equivalence of two groups checked on the basis of their AIEEE scores. As a result of sampling mortality only thirty students in each group were considered for final experiment.

3.3 TOOLS

Keeping in view the requirements of the study following tools were used in the research.

3.3.1 Instructional Tools

Three Instructional tools were developed as given below;

- Orientation lessons-six lesson developed with an objective of helping students to construct concept maps.
- Study material based on concept mapping. It comprises the concept maps on hydrocarbons and functional groups
- Study material for conventional reading. It is in text form usually the text book and covers two areas of chemistry i.e hydrocarbons and functional group.

3.3.2 Measuring tools

1. Two parallel forms of achievement test in chemistry developed by the investigator were used as measuring tool.
2. A concept map construction task was developed by the investigator for categorizing statements of cognitive processes.

3.4 CONSTRUCTION OF ACHIEVEMENT TEST

The construction of achievement test has been constructed by following the usual steps as described below.

1. Planning the Test – Content analysis and framing of Objectives
2. Blue print of the test.
3. First draft of the test – Writing down the items, Organizing and arranging the items.
4. Try out the test – Administration, Scoring, Validity, and Item Analysis (Difficulty Value, Internal Consistency).
5. Final Drafting- Administration, Application.
6. Standardization – Norms and Interpretation.

The steps in construction of achievement test are as following:

3.4.1 Planning of the test– (Objectives and Curriculum Analysis)

For drawing up test specification, the investigator studied two types of literature critically.

- Literature related to test construction.
- Chemistry syllabus of engineering.(B.Tech I Semester.)

In planning the first and most important step is to frame the clear objectives of the test. Generally we make objectives at three different levels of learning viz knowledge, understanding and application. For content analysis investigator identified content to be covered during experiment and investigator decided to include two areas of Chemistry hydrocarbons and functional group She studied the content thoroughly and fragmented it into different parts. The investigator decided following parameters for the test.

- Total weight age.
• Content matter.
• Length of the test.- 40 questions
• Time location.- one hour
• Scoring –objective key

3.4.2. Blue print for preliminary draft of Achievement Test

The next important step in preparing an objective test is to design a blue print of the test. For the present study the researcher made following blue print showing type and level of questions and the unit of content from it is taken along with marks assigned to it. This blue print was then discussed with various teachers dealing with the subject.

Table 3.2

Blue print for Preliminary draft of Achievement Test

<table>
<thead>
<tr>
<th>AREA OF CONTENT</th>
<th>KNOWLEDGE (25%)</th>
<th>UNDERSTANDING (35%)</th>
<th>APPLICATION (40%)</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>SATURATED HYDROCARBON</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>UNSATURATED HYDROCARBON</td>
<td>6</td>
<td>8</td>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td>FUNCTIONAL GROUP &amp; INTER CONVERSIONS</td>
<td>4</td>
<td>10</td>
<td>15</td>
<td>29</td>
</tr>
<tr>
<td>NO OF QUESTION</td>
<td>15</td>
<td>21</td>
<td>24</td>
<td>60</td>
</tr>
</tbody>
</table>

Administration of the first draft of test

First of all permission was sort from the principal to administer the test and to carry out the experiment. The purpose of administering the test was explained to the students and appropriate instructions were given verbally to them. The preliminary draft of achievement test was
administered on Ample of 60 students of B-tech I semester appropriate instructions were given to students before hand and test administered in group and after stipulated time answer sheets were collected from students.

3.4.3 Trying out the test.

Try out of the first form

The test supervisor introduces the test to the trial candidates, explained any practice item, and has ensured that candidates that their results will be used to validate the items and will not have any effect on their current course work, and gathered all test materials before candidates leave the room. For try out of the first form, ten students of B-tech I-semester representing above average, average and below average categories in terms of their achievements were taken. The directions and mode of answering the questions were explained. Complete freedom was given to them to ask about difficulties faced during the test. This preliminary try out on a sample of subjects enabled the investigator to discover deficiencies, which were as undermined in light of feedback given by students the preliminary draft test was revised.

3.4.4 Item Analysis

1. Some of the items were found to be too difficult.
2. The nature of fill up the blanks in concept map based form was not understood.
3. The language of some items was not understood by some students.

Emergence of revised form for item analysis.

The discussion with the ten students as explained above led to the following changes in the test:

1. Some difficult items were replaced by easy items.
2. The language of some items was modified.
3. The concept map based fill ups were replaced by simple fill up the blanks.
Administration of the test for second Try- Out:

The items in the test draft were nearly one and half times the number required in the final draft. The items with wider range were constructed. The instructions to be given to subjects were framed. Then test was administered to a sample of 40 students of B-tech I semester in a group and item analysis done with following purpose.

- To determine the difficulty value of each item.
- To determine discriminating power of each item.
- To determine the time limits for the test.
- To determine the number of items in the test.
- To determine the required improvement in the process of administration of the test.

For item analysis of the test following steps were followed.

a) The test papers were arranged from the highest score to the lowest score (N=40).

b) From the ordered set of papers, two groups were made. Best 27% of papers were placed in upper group and the poorest 27% of papers were placed in lower group. So, 17 papers were selected for each group.

c) For each item, the number of students who answered the item correctly in both the groups was calculated and recorded for the calculation of difficulty index and discrimination power.

Finding the difficulty index and discrimination power of the test.

As a rule the test paper as a whole neither is too easy nor too stiff. For this purpose the difficulty level of the items should be considered by the teacher. After the formation of two groups, the number of correct responses on each item in each group was found out and tabulated. The average of the correct responses on each item in the two groups was taken to be an estimate
of the difficulty value of that particular item. We can write the formula as

$$D.I = \frac{R_u + R_l}{T}$$

D.I = Difficulty index.

Ru = Percentage of right responses in upper group.

Rl = Percentage of right responses in lower group.

T = Total number of pupils in two groups.

The items selected for final draft were mostly of medium difficulty index. (enclosed in Appendix I)

**Finding the discriminating power of the test.**

$$D.I = \frac{R_u + R_l}{\frac{1}{2} T}$$

DP = Discriminating power.

P = Total percentage of right responses

Q = Total percentage of Wrong responses

In discriminating power if the value is less than 0.2 than that item should be rejected and if the value is 0.2 or more than 0.2 than that item should be selected. (enclosed in Appendix II)

**Reliability and validity of final draft.**

**Reliability**

In the present study for estimating the reliability of the test, the split half method was used. The investigator personally scored all the papers. Odd and even items were scored with the help of different colors; odd no of items with red and even with green pen. The total score on each test paper of an individual was the sum of the odd and even. Items scored and the sum was written on the title page of the test paper. 9 odd and even items were scored separately since separate scores on these parts were required for computing
split half reliability. The reliability coefficient of whole test is .81 which is fairly high and indicate that the achievement test is highly reliable. However internal consistency among sub scale of achievement test is given below.

**Table 3.3**

*Internal Consistency of Achievement Tests*

<table>
<thead>
<tr>
<th>Sub scale</th>
<th>‘r’</th>
<th>Full length reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Knowledge</td>
<td>.71</td>
<td>.81</td>
</tr>
<tr>
<td>2. Understanding</td>
<td>.63</td>
<td>.80</td>
</tr>
<tr>
<td>3. Application</td>
<td>.59</td>
<td>.70</td>
</tr>
</tbody>
</table>

From an inspection of table 2 it I evident that the Pearson ‘r’ range from .59 to.71 and full length reliabilities from .70 to .81 and all are significant beyond .05 level of confidence. These internal consistency values reveal that all the sub scale of achievement test are consistent with regard to the dimension measured.

**VALIDITY**

In the present study, an attempt has been made to establish three types of validities.

I. Content validity- as mentioned earlier for content validity opinion of ten subject experts was collected.

II. Intrinsic validity.

III. Face validity.

I -Content validity.

Content validity refers to how well the test contents, sample, subject matter about which conclusions are to be drawn. In the present study, for the estimation of content validity, opinions of ten subject experts was collected on the suitability of the content of the test by putting on the following questions:

1. Are the items quite relevant to the specific learning units considered from the syllabus of B-tech I semester students?
2. Does the present test help in discrimination of poor and good students in chemistry?

3. Would the objective of the test be realized by the items, their arrangement and mode of responses set in the test?

4. Among the ten educational practitioners, all were lecturers of chemistry and two were chemistry teachers, apart from this the principal of college was also consulted, as he was expert in chemistry.

5. Only those items which were agreed upon by majority of judges were included in the preliminary draft of the achievement test

II Intrinsic validity.

Intrinsic validity of a test is directly related with test reliability.

‘The degree to which a test measures, what it measures may be called its ‘intrinsic validity’. It is indicated by the square root of the reliability coefficient and is also designated as ‘index of reliability’.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Area of test</th>
<th>Intrinsic validity</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Alkane</td>
<td>.87</td>
<td>Significant</td>
</tr>
<tr>
<td>b.</td>
<td>Alkene</td>
<td>.49</td>
<td>Significant</td>
</tr>
<tr>
<td>c.</td>
<td>Alkyne</td>
<td>.59</td>
<td>Significant</td>
</tr>
<tr>
<td>d.</td>
<td>Alcohols</td>
<td>.58</td>
<td>Significant</td>
</tr>
<tr>
<td>e.</td>
<td>Aldehydes</td>
<td>.55</td>
<td>Significant</td>
</tr>
<tr>
<td>f.</td>
<td>Carboxylic acids</td>
<td>.54</td>
<td>Significant</td>
</tr>
<tr>
<td>g.</td>
<td>Amines</td>
<td>.57</td>
<td>Significant</td>
</tr>
<tr>
<td>h.</td>
<td>Interconversions</td>
<td>.55</td>
<td>Significant</td>
</tr>
</tbody>
</table>

The validity of the test was taken for granted, because it was an achievement test and was constructed after being keeping in view the weightage of the difficult portion of the syllabus in view, the point of view
is supported by Guilford (1954) and Landguist (1951). Guilford says, “There are some measures whose validity is taken granted, for example, an achievement test scores.

III Face Validity.

Views of subject experts taken for face validity.

3.4.5 Preparation of Final Draft

Final draft of test:

The items for final test were selected on the following criteria of internal with regard to internal consistency of D.V Garrett (1969), says, “As a general rule, item with indices of 0.21 or more are regarded as satisfactory.”

“Item with a reliability coefficient as high as 0.25 usually represents an outstanding valid item. Keeping these in view, the investigator decided to retain only the items having internal consistency between 0.25 to 0.85”. In the light of such findings the unsuitable items can be deleted from the test or other items can be included for making it more suitable. The final form of test contains 40 questions only.

Table 3.5

Blue Print of Final Draft of Achievement Test.

<table>
<thead>
<tr>
<th>AREA OF CONTENT</th>
<th>KNOWLEDGE (25%)</th>
<th>UNDERSTANDING (35%)</th>
<th>APPLICATION (40%)</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>SATURATED HYDROCARBON</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>UNSATURATED HYDROCARBON</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>FUNCTIONAL GROUP &amp; INTER CONVERSIONS</td>
<td>4</td>
<td>9</td>
<td>12</td>
<td>26</td>
</tr>
<tr>
<td>No OF QUESTION</td>
<td>10</td>
<td>14</td>
<td>16</td>
<td>40</td>
</tr>
</tbody>
</table>
After selecting items for the final test, re-arranged them in accordance with the principles laid down by experts. The final form of achievement test consists of forty items. On the cover page of this test, standardized instructions to the testers were pointed as in the case of try-out test. The scoring key for the final test was also prepared and has been given along with the test.

3.4.6 Cognitive process Inventory.

A *Cognitive process Inventory* was created based upon the 6 key cognitive processes identified as discussed above. The wording and format of the questionnaire were reviewed by the classroom teachers for clarity and appropriateness, and revised accordingly. The degree of psychological engagement in various cognitive processes varies from student to student. Each task of concept map construction is accompanied with six questions on cognitive processes. Therefore, for each of the 4 activities in the questionnaire, students first were asked to comment on five questions while making concept maps. For each question one mark is assigned to correct response and zero to incorrect response. Concept maps are evaluated in terms of components viz nodes, link, cross-links and unlabelled links. For each student number of nodes, link, cross-links and unlabelled links made are calculated and that shows his/her score on that component of concept map construction. The higher the number, the more involved the student indicated she was in that particular aspect of concept map (C-map) formation. (see Appendix V for *Cognitive process Inventory*).

3.5. EXECUTION OF EXPERIMENT.

The experiment was executed during a period of 50 days. A brief description about the experiment is presented in the following steps

**Step 1- Seeking of Permission** – At first College Principal was approached and permission was sought for carrying out the experiment.

**Step 2- Selection of Content** – This was to select the content for treatment. It was planned to teach those topics which were not taught.
Content was selected from the syllabus of the MDU for B.Tech Sem-1. The contents to be covered during treatment was same for both the control and experimental groups. The topic chosen were from hydrocarbons and functional groups and were following as given below.

a. Alkane
b. Alkene
c. Alkyne
d. Alcohols
e. Aldehydes
f. Carboxylic acids
g. Amines
h. Interconversions.

**Step 3 – Fixation of schedule for treatment** – The schedule for the data collection was fixed. It is given in the following table given below

<table>
<thead>
<tr>
<th></th>
<th>Schedule of Experimentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Pre Test</td>
</tr>
<tr>
<td>2.</td>
<td>Experimentation</td>
</tr>
<tr>
<td></td>
<td>Learning by conventional reading.</td>
</tr>
<tr>
<td></td>
<td>Learning by Concept-mapping strategy.</td>
</tr>
<tr>
<td></td>
<td>a. Training in Construction of Concept maps</td>
</tr>
<tr>
<td></td>
<td>b. Learning through Concept map lessons.</td>
</tr>
<tr>
<td></td>
<td>7 Feb-19 Feb</td>
</tr>
<tr>
<td>3.</td>
<td>Post Test</td>
</tr>
<tr>
<td>4.</td>
<td>C-map construction and cognitive process task.</td>
</tr>
<tr>
<td>5.</td>
<td>Process analysis rating scale</td>
</tr>
</tbody>
</table>

Note – The College was working from Monday to Friday.
Step 4 – Formation of equivalent groups and administration of pre test.

Two Intact groups of 30 under graduate engineering students studying in I semester of B.tech were taken. Equivalence of two groups was established on basis of AIEEE Scores. The students were given the pretest.

Step 5 – Treatment to experimental group.

After the administration of the pretest, all the instructional plans were delivered to control groups through traditional method of learning, this implies to the learning through conventional reading in the classroom. Parallel to this experimental group was given experimental treatment. The experimental treatment comprised of training in concept map construction and learning the content through teacher made concept maps.

Training in the Concept Mapping Task.

The training in concept mapping included a presentation of a concept mapping technique, followed by six guided practice sessions. The mapping technique presented was a modification of the networking technique (Hall & Dansereau, 1984). In this technique, words or phrases are connected by labeled arrows. In the original networking scheme, arrows were to be labeled with letters that represented a limited set of relational categories. However, as presented to the participants of this study, arrows might be labeled with any word or phrase to identify the relationship between two concepts. Participants were allotted 20 minutes to generate concept maps from the text passage using the listed concepts. While the participants worked on their concept maps, a researcher was available to offer advice and answer questions about the mapping technique. This procedure was repeated for six separate practice exercises. After each practice exercise, students were shown a map created by the researchers and encouraged to compare it to their map and ask questions. To allow students to concentrate on the mapping technique, the six text passages were selected so as to present material that would be generally familiar to the mappers. The passages presented were related to Chemistry but different from content selected for
treatment during experimentation which is listed below.

(a) An introduction to hydrocarbons
(b) functional groups and
(c) Interconversion among functional groups.

Learning through Concept Maps

It involves the use of teacher made concept map based lessons for learning. The researcher assisted students for eleven days to clear the concept for selected content via the concept maps developed by herself for the study.

Step 6: Administration of post tests

At the end of the treatment post test was administered to both experimental and control group at the same time. Parallel form of achievement test made by the investigator was used as post test. The students were given one hour for the test and investigator was present there with the students for any query. After completion of post test students of experimental group were asked to construct concept maps which were evaluated by the researcher by giving one mark to each correct response of the step.

Step 7 – Administration of Delayed test

A delayed test was taken after a period of four weeks to measure retention in learning.

3.6 STATISTICAL TECHNIQUES USED

Depending on the design and objectives of the study different statistical techniques were used for the analysis of the data. These statistical techniques are mentioned as under.

1. Mean and S.D were worked out to understand the nature of data.
2. The t-test was employed to find out the significance of difference between control and experimental groups, in terms of achievement and retention.
3. The product moment method of correlation was used to calculate coefficient of correlation to see the relation between different variables.

4. Cluster analysis was done to identify different mapping styles.

5. Manova carried out to see the effect of mapping styles on achievement and retention.

6. Tukeys HSD test was used for Post hoc analysis to compare the effect of clusters.