CHAPTER II
Chapter – III

DESIGN OF THE PROBLEM

3.0 Introduction

As discussed in Chapter I the main objective of the present study is to test the Effect of Concept Mapping on Science Achievement of Secondary School Students as Moderated by Cognitive Ability, Problem Solving and Scientific Aptitude.

Research design is the Blue Print of the procedure that enables a researcher to test hypotheses by reaching validity conclusions about relationships between independent and dependent variables. The present investigation which determines the relative effect of Concept Mapping in Biology, is an experimental study. The effectiveness has been studied in terms of pupils achievement in Biology besides this Cognitive ability, Problem solving and Scientific aptitude has also been studied.

3.1 General Statement of the Problem

The present problem can be restated as "Effect of Concept Mapping on Science Achievement of Secondary School Students as Moderated by Cognitive Ability, Problem Solving and Scientific Aptitude" – is the problem selected for research.

3.2 The Variables Considered in the Study

The following are the variables considered for the present study.

1) Control Variables

   a) Concept Mapping Strategy
   b) Conventional Method
2) **Dependent Variable**
   a) Achievement in Biological Science

3) **Independent Variables**
   a) Cognitive Ability
   b) Problem Solving Ability
   c) Scientific Aptitude

4) **Personal Variables**
   a) Gender (Male / Female)
   b) Locality (Rural / Urban)

   The above variables were selected by taking into the account of the effectiveness of concept mapping on science achievement of secondary school students is moderated by cognitive ability, problem solving ability and scientific aptitude. Also the selection of the above variables are based on review of related literatures, researcher's experience and experts opinion.

3.3 **The Rationale for Choosing the Variables**

   i. Boys versus girls
   ii. Rural versus Urban

   The rationale for choosing the above stated variables is discussed herewith.

3.3.1 **Boys Versus Girls**

   Gender was taken as a variable to see if there is any significant difference between boys and girls in finding the effect of concept mapping, cognitive ability, problem solving ability, scientific aptitude and achievement in science.
3.3.2 Rural Schools Versus Urban Schools

The Urban schools are well equipped in many aspects when compared with the Rural schools. The buildings, the libraries, the laboratories, the teaching staff, the competitive spirit among the pupils, the use of audio-visual aids will always be better in urban schools than in rural schools. They play a commendable role in the acquisition of concept mapping, cognitive ability, problem solving ability and scientific aptitude. A comparison between rural and urban school pupils will bring out the differences in the achievement in science due to the effect of concept mapping, cognitive ability, problem solving ability and scientific aptitude.

3.4 Scope of the Study

The present study was limited to IX standard students of Coorg Districts (State syllabus) and the result in their examination had lot of significance to the individual and to the school. The students need to put up an improved performance in the examinations.

Achievement test in science constructed by the researcher, helped them for revision and preparation of their exams, for better performance. For the above reasons the students of IX standard were involved in the present study.

3.5 Objectives of the Study

The objectives of the study are as follows.

- To study the significant difference between pre-test and post-test scores of science achievement of secondary school students in control group.
- To study the significant difference between pre-test and post-test scores of scientific aptitude of secondary school students in control group.
• To study the significant difference between pre-test and post-test scores of science achievement of secondary school students in experimental group.

• To study the significant difference between pre-test and post-test scores of scientific aptitudes of 1st trimester, 2nd trimester, 3rd trimester and their total of secondary school students in experimental group.

• To study the significant difference between pre-test and post-test scores of scientific aptitude of secondary school students in experimental group.

• To study the significant difference between control and experimental group with respect to pre-test and post-test scores of science achievements of secondary school students.

• To study the significant difference between control and experimental group with respect to pre-test scores of concept mapping in 1st, 2nd, 3rd trimester and their total of secondary school students.

• To study the significant difference between control and experimental group with respect to pre-test and post-test scores of scientific aptitude of secondary school students.

• To study the significant difference between control and experimental group with respect to cognitive ability scores and problem solving ability scores of secondary school students.

• To study the significant difference between control and experimental group with respect to pre-test and post-test scores of science achievements of rural secondary school students.

• To study the significant difference between control and experimental group with respect to pre-test scores of concept mapping in 1st, 2nd, 3rd trimester and their total of rural secondary school students.
• To study the significant difference between control and experimental group with respect to pre-test and post-test scores of scientific aptitude rural secondary school students.

• To study the significant difference between control and experimental group with respect to cognitive ability scores and problem solving ability scores of rural secondary school students.

• To study the significant difference between control and experimental group with respect to pre-test scores of science achievements of urban secondary school students.

• To study the significant difference between control and experimental group with respect to pre-test and post-test scores of science achievements of secondary school boy students.

• To study the significant difference between control and experimental group with respect to pre-test scores of concept mapping in 1st, 2nd, 3rd trimester and their total of secondary school boy students.
• To study the significant difference between control and experimental group with respect to pre-test and post-test scores of scientific aptitude of secondary school boy students.

• To study the significant difference between control and experimental group with respect to cognitive ability scores and problem solving ability scores of secondary school boy students.

• To study the significant difference between control and experimental group with respect to pre-test and post-test scores of science achievement of secondary school girl students.

• To study the significant difference between control and experimental group with respect to pre-test scores of concept mapping in 1st, 2nd, 3rd trimester and their total of secondary school girl students.

• To study the significant difference between control and experimental group with respect to pre-test and post-test scores of scientific aptitude of secondary school girl students.

• To study the significant difference between control and experimental group with respect to cognitive ability scores and problem solving ability scores of secondary school girl students.

• To study the significant difference between rural and urban secondary school students with respect to pre-test and post-test scores of science achievement.

• To study the significant difference between rural and urban secondary school students with respect to pre-test and post scores of concept mapping in 1st, 2nd, 3rd trimester and their total.
- To study the significant difference between rural and urban secondary school students with respect to pre-test and post-test scores of scientific aptitude.
- To study the significant difference between rural and urban secondary school students with respect to cognitive ability scores and problem solving ability.
- To study the significant difference between boy and girl students of secondary schools with respect to pre-test and post-test scores of science achievement.
- To study the significant difference between boy and girl students of secondary schools with respect to pre-test and post scores of concept mapping in 1st, 2nd, 3rd trimester and their total.
- To study the significant difference between boy and girl students of secondary schools with respect to pre-test and post-test scores of scientific aptitude.
- To study the significant difference between boy and girl students of secondary schools with respect to cognitive ability scores and problem solving ability.
- To study the significant difference between high and low concept mapping of secondary school students with respect to pre-test and post science achievement scores in experimental and control group and as a whole.
- To study the significant difference between high and low scientific aptitude of secondary school students with respect to pre-test and post science achievement scores in experimental and control group and as a whole.
• To study the significant difference between high and low cognitive ability of secondary school students with respect to pre-test and post science achievement scores in experimental and control group and as a whole.

• To study the significant difference between high and low problem solving ability of secondary school students with respect to pre-test and post science achievement scores in experimental and control group and as a whole.

• To study the significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school total students.

• To study the significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school students in control group.

• To study the significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school students in experimental group.

• To study the significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of rural secondary school students.

• To study the significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of urban secondary school students.

• To study the significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school boy students.
• To study the significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school girl students.

• To study the difference between Concept mapping, scientific aptitude, cognitive ability and problem solving ability are significant predictors of science achievement of secondary school total students.

• To study the difference between Concept mapping, scientific aptitude, cognitive ability and problem solving ability are significant predictors of science achievement of secondary school students in control group.

• To study the difference between Concept mapping, scientific aptitude, cognitive ability and problem solving ability are significant predictors of science achievement of secondary school students in experimental group.

• To study the difference between Concept mapping, scientific aptitude, cognitive ability and problem solving ability are significant predictors of science achievement of rural secondary school students.

• To study the difference between Concept mapping, scientific aptitude, cognitive ability and problem solving ability are significant predictors of science achievement of urban secondary school students.

• To study the difference between Concept mapping, scientific aptitude, cognitive ability and problem solving ability are would not be significant predictors of science achievement of secondary school girl students.
• To study the significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school total students.

• To study the significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school students in control group.

• To study the significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school students in experimental group.

• To study the significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of rural secondary school students.

• To study the significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of urban secondary school students.

• To study the significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school boy students.

• To study the significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school girl students.
3.6 Hypotheses of the Study

In pursuance of the above stated objectives the following hypotheses were formulated.

\( H_1 \) There is no significant difference between pre-test and post-test scores of science achievement of secondary school students in control group.

\( H_2 \) There is no significant difference between pre-test and post-test scores of scientific aptitude of secondary school students in control group.

\( H_3 \) There is no significant difference between pre-test and post-test scores of science achievement of secondary school students in experimental group.

\( H_4 \) There is no significant difference between pre-test and post-test scores of scientific aptitudes of 1\(^{st}\) trimester, 2\(^{nd}\) trimester, 3\(^{rd}\) trimester and their total of secondary school students in experimental group.

\( H_5 \) There is no significant difference between pre-test and post-test scores of scientific aptitude of secondary school students in experimental group.

\( H_6 \) There is no significant difference between control and experimental group with respect to pre-test and post-test scores of science achievements of secondary school students.

\( H_7 \) There is no significant difference between control and experimental group with respect to pre-test scores of concept mapping in 1\(^{st}\), 2\(^{nd}\), 3\(^{rd}\) trimester and their total of secondary school students.

\( H_8 \) There is no significant difference between control and experimental group with respect to pre-test and post-test scores of scientific aptitude of secondary school students.
$H_9$ There is no significant difference between control and experimental group with respect to cognitive ability scores and problem solving ability scores of secondary school students.

$H_{10}$ There is no significant difference between control and experimental group with respect to pre-test and post-test scores of science achievements of rural secondary school students.

$H_{11}$ There is no significant difference between control and experimental group with respect to pre-test scores of concept mapping in $1^{st}$, $2^{nd}$, $3^{rd}$ trimester and their total of rural secondary school students.

$H_{12}$ There is no significant difference between control and experimental group with respect to pre-test and post-test scores of scientific aptitude rural secondary school students.

$H_{13}$ There is no significant difference between control and experimental group with respect to cognitive ability scores and problem solving ability scores of rural secondary school students.

$H_{14}$ There is no significant difference between control and experimental group with respect to pre-test and post-test scores of science achievement of urban secondary school students.

$H_{15}$ There is no significant difference between control and experimental group with respect to pre-test scores of concept mapping in $1^{st}$, $2^{nd}$, $3^{rd}$ trimester and their total of urban secondary school students.

$H_{16}$ There is no significant difference between control and experimental group with respect to pre-test and post-test scores of scientific aptitude of urban secondary school students.
H17 There is no significant difference between control and experimental group with respect to cognitive ability scores and problem solving ability scores of urban secondary school students.

H18 There is no significant difference between control and experimental group with respect to pre-test and post-test scores of science achievements of secondary school boy students.

H19 There is no significant difference between control and experimental group with respect to pre-test scores of concept mapping in 1st, 2nd, 3rd trimester and their total of secondary school boy students.

H20 There is no significant difference between control and experimental group with respect to pre-test and post-test scores of scientific aptitude of secondary school boy students.

H21 There is no significant difference between control and experimental group with respect to cognitive ability scores and problem solving ability scores of secondary school boy students.

H22 There is no significant difference between control and experimental group with respect to pre-test and post-test scores of science achievement of secondary school girl students.

H23 There is no significant difference between control and experimental group with respect to pre-test scores of concept mapping in 1st, 2nd, 3rd trimester and their total of secondary school girl students.

H24 There is no significant difference between control and experimental group with respect to pre-test and post-test scores of scientific aptitude of secondary school girl students.
H25 There is no significant difference between control and experimental group with respect to cognitive ability scores and problem solving ability scores of secondary school girl students.

H26 There is no significant difference between rural and urban secondary school students with respect to pre-test and post-test scores of science achievement.

H27 There is no significant difference between rural and urban secondary school students with respect to pre-test and post scores of concept mapping in 1st, 2nd, 3rd trimester and their total.

H28 There is no significant difference between rural and urban secondary school students with respect to pre-test and post-test scores of scientific aptitude.

H29 There is no significant difference between rural and urban secondary school students with respect to cognitive ability scores and problem solving ability.

H30 There is no significant difference between boy and girl students of secondary schools with respect to pre-test and post-test scores of science achievement.

H31 There is no significant difference between boy and girl students of secondary schools with respect to pre-test and post scores of concept mapping in 1st, 2nd, 3rd trimester and their total.

H32 There is no significant difference between boy and girl students of secondary schools with respect to pre-test and post-test scores of scientific aptitude.
H33 There is no significant difference between boy and girl students of secondary schools with respect to cognitive ability scores and problem solving ability.

H34 There is no significant difference between high and low concept mapping of secondary school students with respect to pre-test and post science achievement scores in experimental and control group and as a whole.

H35 There is no significant difference between high and low scientific aptitude of secondary school students with respect to pre and post science achievement scores in experimental and control group and as a whole.

H36 There is no significant difference between high and low cognitive ability of secondary school students with respect to pre and post science achievement scores in experimental and control group and as a whole.

H37 There is no significant difference between high and low problem solving ability of secondary school students with respect to pre and post science achievement scores in experimental and control group and as a whole.

H38 There is no significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school total students.

H39 There is no significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school students in control group.
H₄₀ There is no significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school students in experimental group.

H₄₁ There is no significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of rural secondary school students.

H₄₂ There is no significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of urban secondary school students.

H₄₃ There is no significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school boy students.

H₄₄ There is no significant relationship between concept mapping, scientific aptitude, cognitive ability and problem solving ability and science achievement of secondary school girl students.

H₄₅ Concept mapping, scientific aptitude, cognitive ability and problem solving ability are would not be significant predictors of science achievement of secondary school total students.

H₄₆ Concept mapping, scientific aptitude, cognitive ability and problem solving ability are would not be significant predictors of science achievement of secondary school students in control group.

H₄₇ Concept mapping, scientific aptitude, cognitive ability and problem solving ability are would not be significant predictors of science achievement of secondary school students in experimental group.
Concept mapping, scientific aptitude, cognitive ability and problem solving ability are would not be significant predictors of science achievement of rural secondary school students.

Concept mapping, scientific aptitude, cognitive ability and problem solving ability are would not be significant predictors of science achievement of urban secondary school students.

Concept mapping, scientific aptitude, cognitive ability and problem solving ability are would not be significant predictors of science achievement of secondary school boy students.

Concept mapping, scientific aptitude, cognitive ability and problem solving ability are would not be significant predictors of science achievement of secondary school girl students.

There is no significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school total students.

There is no significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school students in control group.

There is no significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school students in experimental group.

There is no significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of rural secondary school students.
There is no significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of urban secondary school students.

There is no significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school boy students.

There is no significant direct and indirect effect of concept mapping, scientific aptitude, cognitive ability and problem solving ability on science achievement of secondary school girl students.

3.7 Definitions of Operational Technical Terms

Some of the technical terms are frequently used in the present study which are defined below:

1. Concept Mapping

A concept mapping has been defined by Novok and Gowin (1984) as a schematic device for representing a set of concept meanings embedded in a framework of propositions.

2. Conventional Method

It is a teacher centered and traditional method of teaching with due weightage given to chalk and talk. It is based on Herbartian stages of teaching using lesson plan, charts and maps. Lecture and demonstration method will be followed simultaneously or in separate.

3. Science Achievement

The knowledge attained or skills developed in the science subject, usually designated by test scores assigned by teachers.
Thorndike and Hagen (1970) define that achievement are performances based to show what a pupil has already learnt to do in the field of science.

Science achievement has been operationally defined as the sum total of achievement made in the subjects of physics, chemistry and biology taken together as science.

4. Mental Ability

Ability to make successful and rapid adaptation to new situations and to learn from experience.

5. Problem Solving Ability

Which is one of the aspects of cognition depends on environmental factors and individual factors like personality. Problem solving is the framework or pattern within which creative thinking and reasoning takes place. It is the ability to think and reason on levels of complexity.

6. Scientific Aptitude

A group of characteristics, native or acquired, deemed to be sympathetic of an individual's ability to acquire proficiency in a given area science.

7. Standard IX

It is the second division of the three year secondary stage of education in Karnataka, which starts with VIII passes though IX.

8. Gender

In the present study the term gender refers to the sex of students (Boys and Girls).

9. Type of School

Among different types of schools the researcher in the present study considered the following two types of schools, they are:
Aided Schools - These schools refer to the secondary schools run by private management's, missionaries and other religious bodies which receive grant-in-aid from the state government.

Unaided Schools - these schools refer to the secondary schools run by private management's, missionaries and other religious bodies which do not receive any grant-in-aid from the state government.

10. Locality

Urban Schools - the schools located in an urban area were considered urban schools. An urban area should have a minimum population of 20 thousands.

Rural Schools - the schools located in rural areas were considered as rural schools. A rural area should have a population below 10 thousands, with 75% of the population engaged in agricultural pursuits.

11. Tests

Pre-test - Test given to students before taking to a test his/her suitability for it. This test is administered before applying experimental variable, concept mapping strategy and conventional method and by comparison with a post-test to gauge the program's effectiveness.

Post-test - Test administered at the end of the experimental treatment and conventional method to check the programme.

3.8 Design of the Study

The present study is aimed at finding out the contributing factors in relation to Science Achievement of IX standard students. The accuracy of results of any research work depends upon the method adapted and the tools used for collecting relevant data. The details of the sample selected, tools
used, administration of the tools and stratified technique used are described in this chapter.

3.9 Methodology of the Study

The hypotheses formulated helped the researcher to frame the methodology of the study.

The methodology of the present study consists of the following steps –

a) Sample of the study
b) Tools used for the study
c) Tools and its description
d) Data collection procedure
e) Statistical techniques
f) Limitations of the study
g) Scope of the study

3.9.1 Sample of the Study

The study involved a sample of $n=241$, IX standard students of Coorg districts in such a way as to make available all categories of schools. Stratified random sampling technique is used to select the sample for the study.

Table 3.1: Table showing break up of sample in terms of variables

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Variables</th>
<th>Sex</th>
<th>Rural</th>
<th>Urban</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Experimental</td>
<td>Male</td>
<td>36</td>
<td>11</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female</td>
<td>44</td>
<td>30</td>
<td>74</td>
</tr>
<tr>
<td>2</td>
<td>Control</td>
<td>Male</td>
<td>45</td>
<td>20</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female</td>
<td>34</td>
<td>21</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>159</td>
<td>82</td>
<td>241</td>
</tr>
</tbody>
</table>
3.9.2 Tools Used for the Study

The following tools were used for data collection:

1) Concept Mapping in 9th Biology*
2) Conventional Method
3) Science Achievement Test*
4) Cognitive Ability – OTIS General Mental Ability Test
5) Problem Solving Ability Test
6) Scientific Aptitude Test*

* = Constructed and Standardized by the Researcher

3.9.3 Tools and Its Description

The following tools were used for collecting the required data for the assessment of dependent and independent variables.

Development of Concept Mapping

Concept mapping is constructed and developed by the investigator. It is intended to develop concept mappings in order to learn the subject matter of Biological Science through concept mappings and to know the effect of concept mappings on Science Achievement of IX Biology Science Achievement. The following steps have been taken in the construction of concept mapping.

- Write down major terms of concept about a topic

Select and read the chapter from a textbook on a particular topic and identify the key concepts necessary for understanding the topics and make a list of their names. In the present study, the investigator identified and selected concepts from each unit of IX standard Biological Science.
• **Identify the most general, intermediate and specific concepts**

  Decide, which concept is the most important and most exclusive idea and make a list with this concept at the top. From this list a rank order should be established from the most general, most inclusive concept, to most specific, least general concept.

• **Begin drawing the concept maps**

  Begin constructing a concept map by placing the name of the broadest most inclusive concept on the top of the paper work done adding more concepts. Sometime this may be located along side of each other. Usually it is most sensible to have them in descending order one below the other. Enclose each term in box or circle. Investigator has selected rectangular box to place concepts in each box.

• **Draw lines between related concepts**

  Join the concepts with the lines and label the lines with linking words that show meaningful connection between the concepts. At first we must formulate the word or words that accurately described the relationship between the super ordinate concept and subordinate concept relates to it. These are linking words or prepositions. Linking concept is the most important aspect of concept mapping. Some of the examples of the linking words used to describe the relationships are composed of 'includes', 'depends on', 'is influenced by', 'cause' and 'is affected by'.

• **Finish mapping all concepts selected from the topic**

  The next step is to combine to make up the map grown by relating additional concepts from the list prepared to concept already on the map. Continue with the inclusive terms first, working the way down to the most specific terms until all the concepts are mapping in.
• **Use of cross links**

Study the map to see if there are any relevant relationships that should be illustrated between terms on the map. Such relationships if exists between two concepts or two propositions in different vertical segment of the concept map cross links help to integrate the concept map into a cohesive whole cross links can be constructed at any point in the mapping process. Infact the learner will often see crosslinks when only some or the terms have been mapped.

• **Indicate cause effect relationship**

When the concepts are linked together to form a cause effect relationships an arrow is used to show the direction of the relationship. Not all links are to be one way.

The investigator held discussion with the high school teachers and subject experts after thorough reference of the Biology content of IX standard and constructed 48 concept mappings covering all the Biology units prescribed in the state syllabus.

In the pilot study, 48 concept mappings were administered to individual tryout and small group and large group of students, after the evaluation of the test administered by looking into the majority of the students who have attempted to answer the concept mappings. The investigator and the team of experts have retained only 36 concept mappings were retained in the final form.

After going through all responses if individual, small group and large group test also consulted experts opinion about the responses on each concept mapping, 36 concept mappings were retained. 36 concept mappings which were ranged from first to last chapter, divided into three trimester test. In the first trimester four concept mappings, (serial no from 1 to 4) items, in
the second trimester 14 concept mappings (serial no from 5 to 18) items and in the third trimester 18 concept mappings (serial no from 19 to 36) were tried and tested on the sample of n=241, both boys and girls from rural and urban areas. Please see Appendix-A for all the concept maps.

Development of Conventional Method

The method of teaching science which is widely being used by secondary school teachers is referred to as the conventional method. This method is text book centered, teacher dominant, chalk and talk based and examination oriented. Here the pupils are mainly passive listeners and the emphasis is mainly on remembering and producing. Please see Appendix-B for further details of conventional method.

Development of Science Achievement Test in Biology

There are various general science achievements. Tests available but they did not meet the requirements of the present study as the researcher wanted an achievement test only in Biology for class IX students, Therefore, a need was felt to construct a test for the purpose of assessing achievement test in biology of 14-15 years old pupils, who constituted the sample of the study.

The objective type test was considered to be the most suitable. The researcher kept in mind the important characteristics of objective type tests. These tests may include more than one type of items and have ability to discriminate different levels of students.

Blue Print of Achievement Test in Biology

The objectives of the test were taken from Bloom's Taxonomy of educational objectives in Cognitive domain, they are

a) Knowledge
b) Understanding

c) Application

Knowledge is considered by any of the following behaviors like to recall, to recognize, to show information on charts, diagrams, etc. without involving any substantive manipulation skills.

Understanding is to be considered by any of the following behavior to change, to classify, to distinguish, to explain, to identify, to illustrate and to inculcate, to justify, to represent, to summarize, to transform and to translate.

Application is to be considered by any of the following behavior, to assess, to construct, to demonstrate, to explain, to compute, to establish, to generate, to modify, to predict, to perform, to solve etc.

The test was based on source content given in Karnataka State Educational Board textbook of biology for class IX. The weightage of marks for each content and percentage of items of Knowledge, Understanding, Application and Skill were based on examination pattern of the Karnataka State. The medium of the test was English. The test includes multiple choice items.

Table 3.2: Showing the Blue Print

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Content</th>
<th>Knowledge</th>
<th>Understanding</th>
<th>Application</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Living World</td>
<td>9</td>
<td>3</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>The Study of the Cells</td>
<td>16</td>
<td>2</td>
<td>1</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>Micro Organisms</td>
<td>30</td>
<td>5</td>
<td>3</td>
<td>38</td>
</tr>
<tr>
<td>4</td>
<td>The Life Processes</td>
<td>47</td>
<td>3</td>
<td>1</td>
<td>51</td>
</tr>
<tr>
<td>5</td>
<td>Food Production and Management</td>
<td>32</td>
<td>5</td>
<td>3</td>
<td>40</td>
</tr>
<tr>
<td>6</td>
<td>Environmental Science</td>
<td>25</td>
<td>12</td>
<td>0</td>
<td>37</td>
</tr>
<tr>
<td>7</td>
<td>The Evolution of Life</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>169</td>
<td>30</td>
<td>9</td>
<td>208</td>
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</tbody>
</table>
### Table 3.3: Showing the Content-wise Weightage

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Content</th>
<th>Marks</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Living World</td>
<td>13</td>
<td>6.25%</td>
</tr>
<tr>
<td>2</td>
<td>The Study of the Cells</td>
<td>19</td>
<td>9.13%</td>
</tr>
<tr>
<td>3</td>
<td>Micro Organisms</td>
<td>38</td>
<td>18.27%</td>
</tr>
<tr>
<td>4</td>
<td>The Life Processes</td>
<td>51</td>
<td>24.52%</td>
</tr>
<tr>
<td>5</td>
<td>Food Production and Management</td>
<td>40</td>
<td>19.23%</td>
</tr>
<tr>
<td>6</td>
<td>Environmental Science</td>
<td>37</td>
<td>17.79%</td>
</tr>
<tr>
<td>7</td>
<td>The Evolution of Life</td>
<td>10</td>
<td>4.81%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>208</td>
<td>100%</td>
</tr>
</tbody>
</table>

### Table 3.4: Showing the Objective-wise Weightage

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Objectives</th>
<th>No. of Questions</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge</td>
<td>169</td>
<td>81.25%</td>
</tr>
<tr>
<td>2</td>
<td>Understanding</td>
<td>30</td>
<td>14.42%</td>
</tr>
<tr>
<td>3</td>
<td>Skill</td>
<td>09</td>
<td>4.33%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>208</td>
<td>100%</td>
</tr>
</tbody>
</table>

### Table 3.5: Showing the Weightage to Items

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Content</th>
<th>Type of Items</th>
<th>Total No. of Items</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Living World</td>
<td>M.C.</td>
<td>13</td>
<td>6.25%</td>
</tr>
<tr>
<td>2</td>
<td>The Study of the Cells</td>
<td>M.C.</td>
<td>19</td>
<td>9.13%</td>
</tr>
<tr>
<td>3</td>
<td>Micro Organisms</td>
<td>M.C.</td>
<td>38</td>
<td>18.27%</td>
</tr>
<tr>
<td>4</td>
<td>The Life Processes</td>
<td>M.C.</td>
<td>51</td>
<td>24.52%</td>
</tr>
<tr>
<td>5</td>
<td>Food Production and Management</td>
<td>M.C.</td>
<td>40</td>
<td>19.23%</td>
</tr>
<tr>
<td>6</td>
<td>Environmental Science</td>
<td>M.C.</td>
<td>37</td>
<td>17.79%</td>
</tr>
<tr>
<td>7</td>
<td>The Evolution of Life</td>
<td>M.C.</td>
<td>10</td>
<td>4.81%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>208</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Item Analysis**

Item analysis is an essential part of test construction. For this, responses of students about each item were analyzed. Each item test described by two indices. Difficulty value of item and of discrimination index for getting difficulty value, response of 27 percentage of students and bottom
27 students was noted and arranged in descending order. Difficulty value and discrimination index for each item was calculated. Only those items were selected which were having difficulty index value more than 0.2. The items having discrimination index between 25 to 75 percentage were selected. Thus, selected item constituted final form of the test. Please see Appendix-C₂ for details.

Final Form of Achievement Test in Biological Science

The final form of the test consisted 90 items of multiple choice type. The duration of test was 90 minutes. The items were checked for their language and were arranged in logical sequence. The test was also discussed with the subject experts. The reliability and validity of the test was determined. Please see Appendix-C₁ for questionnaire along with scoring key.

Reliability of the Achievement Test in Biological Science

1) Co-efficient of Stability

The coefficient of stability of the science achievement test was determined by the test-retest method. For this purpose the achievement test was re-administered to a random sample of 200 students involved in the first try out two weeks after the first administration. Then correlation between the test and retest scores was computed. The coefficient of correlation between the two sets of scores on the science achievement test was found to be 0.8609, which is quite significant at 0.05 level. This implies that the science achievement test has stability and reliability.

2) Co-efficient of Consistency

The coefficient of consistency of the achievement test was determined by the split-half method. For this purpose scores obtained on the achievement
test to the 200 students involved. The total scores were divided into two halves – one relating to odd numbered items and the other to even numbered items. The obtained coefficient of correlation between the scores on the halves was corrected for full length of achievement test by means of Spearmen Brown prophecy formula (Garrett, 1966, p. 339). The coefficient of consistency of the science achievement test was found to be 0.8443 for full length of the scale, which is significant at 0.05 level. This implies that the science achievement test has consistency reliability. Please see Appendix-C3 for computation of consistency coefficient of achievement test in science.

**Validity of the Achievement Test**

1) **Intrinsic Validity**

Intrinsic validity of the science achievement test was computed from its reliability coefficients (Guilford, 1954, p. 399). The range of validity coefficient was between 0.7307 and 0.7854, which indicates the intrinsic validity of the test.

2) **Content Validity**

Three teachers of secondary schools teaching science acted as judges and collected opinion from the three B.Ed. college lecturers of physics in establishing content validity of the science achievement test. The judges were fully satisfied with the relevance of the test items and the scoring procedures. They were also satisfied with the adequate coverage of content of biology at IX standard. This implies that the achievement test in biology is comprehensive and relevant.

3) **Concurrent Validity**

Concurrent validity of the achievement test was computed by taking relationship between classroom test scores and science achievement test scores and the concurrent validity of the test was found to be 0.7558 which is
found to be significant at 0.05 level. Please see Appendix-C4 for computation of concurrent validity.

**Otis Test of Mental Ability (MA)**

Otis self administering test of mental ability by author M. Otis and T. N. Buros, Indian adoption and standardization by Chauhan N. S. and Govind Tiwari, is one of the best known intelligence tests. The test consists of 75 items, arranged in a mixed form. The test booklet provides needed directions on the first page. The testee underlines the correct answer out of several alternate ones and additionally places the number of the correct answer in a single column provided at the edge of each test item. This ensures simplification of scoring. The time allowed for the test is 30 minutes. This test has values of reliabilities and validity coefficients which were found significant.

The manual of otis mental ability test provides scoring key and t-scores conversion table, according to which the scores are converted into t-scores. Please see Appendix-D for the test along with the directions and scoring key.

**Description of Problem Solving Ability**

Problem Solving is the framework or pattern within which Creative thinking and reasoning takes place. It is the ability to think and reason on given levels of complexity. People who have learned effective problem solving techniques are able to solve problems at higher levels of complexity than more intelligent people who have no such training. It has been found that persons having higher intelligence and reasoning, can solve the complex problems quickly. Therefore, it is necessary that on one hand we try to develop intelligence and reasoning ability and on the other hand we should also develop the problem solving ability through proper education and training of our young students.
This test helps to measure the Problem Solving Ability in order to plan the training programme. This test also has productive value. Problem Solving Ability is highly correlated with intelligence, reasoning ability and mathematical ability. The Problem Solving Ability Test has been standardized over a representative population of 1640 students selected from higher secondary schools, colleges and universities, the students belonging to all the socio economic status and varied intelligence. The range of sample was from 12 years to 17 years. The Reliability Co-efficient of the test by Spearman-Broan Formula (Split-half method) was 0.782 and by Kudar-Richardson Formula (Rational equivalence method) was 0.768. The coefficient of validity was calculated by correlating the scores with the group intelligence test (R.K.Tandon) : 0.682 and test of Reasoning Ability : 0.852. The time limit for the test is exactly 40 minutes. Therefore, the tester should be very particular about time. Please see Appendix-E for the test along with the directions and scoring key.

Scientific Aptitude

To measure the scientific aptitude, the test was constructed and standardized by the investigator has been used to collect the data.

The test is intended to measure the candidates knowledge in the field of science and his potential ability of IX standard students. The details of test construction is as follows:

Development of Scientific Aptitude Test

According to Encyclopedic dictionary and directory of education (1987), aptitude test is a test designed to measure the potential ability of a person for performing a certain type of capacity.
An aptitude test is a standardized test designed to measure the ability of an individual to develop skills or acquire knowledge (great illustrated dictionary - 1984). Aptitude tests (Best -1982) attempt to predict the degree of achievement that may be expected from individuals in a particular activity to the extent that they measure past learning.

Scientific aptitude test is meant for assessment of the ability of an individual's performance in Science. Here, in the present study, it is meant for the measurement of secondary school pupil's aptitude and achievement in Science.

1. Need for Developing the Scientific Aptitude Test

For the purpose of the present study, the scientific aptitude test was constructed and standardized by the investigator himself. There are various Scientific Aptitude Tests, such as Zyve-1930; Guha-1957; Sharma-1963; Dave-1964; Sinha & Sinha-1969; Pratap-1972; Agarwal-1973; are available. Globalizing, that the scientific aptitude to be a compound of abilities, Zyve-1930 developed exercises to measure eleven of these components including ability to suspend judgement, to detect fallacies and inconsistencies, to reason logically and originally and to draw correct inductions and deductions.

Dave's (1964) Scientific Aptitude Test was designed to select students for science at the university level, was standardized on a sample of 1218 SSC students in Gujarat schools.

Deshpande's (1967) Aptitude test of science was means for selecting students for science courses at the end of class eight, on the sample of 856 students from seven schools of Nagpur and Amaravathi.

Venkataramana (1970) devised a test for assessing aptitude for science. He standardized the test on a sample of 2000 students of IX class drawn from 32 schools in Andhra Pradesh.
Pratap (1972) developed an aptitude test comprised of 8 specific areas like analogies, classification, numerical reasoning, verbal reasoning, pictorial reasoning, space relation, Engineering and Science. And, the battery constructed by Omen.

The extensive review of the related and relevant literature revealed that no suitable test to measure scientific aptitude among IX class students. As the passed out students who have to face different types of exams to get into suitable studies, feel the need of scientific aptitude test for IX class students. Keeping the objectives of study in mind, the investigator developed the scientific aptitude test which can be used to measure the scientific aptitude of a science student.

2. Characteristics of Scientific Aptitude and Final Selection

After a thorough search for the relevant literature, a list of those characteristics, which may be assured to measure of scientific aptitude was prepared. The list included the following 10 characteristics of the scientific aptitude.

1) Scientific Interest
2) Experimental Bent
3) Ability to Reason
4) Ability to Interpret
5) Logical Reasoning
6) Ability to see relationships
7) Verbal Comprehension Interpretation
8) Logical Conclusion
9) Data Interpretation
10) Accuracy of observation
3. Trial off preliminary form of the test

Try out is a necessary step in the construction of objective type test. It helps in knowing the difficulty value and discriminative power of various items. Which in turn helps in eliminating ambiguous items or items having low discriminative power are invalid items. This process ensures that the suitability of the items and helps in arriving of final form of the test. The preliminary form of the test of 105 items was administrated to 200 students of IX standard.

4. Item Analysis and preparation of the final form of the test

After administering the preliminary form of the test, the investigator undertook the preparation of final form of the test of 48 items. To get the objectives fulfilled, the scores of 200 students on whom the preliminary form of the test was administered, were arranged in descending order, the highest score appearing on the top and the lowest at the bottom. The difficulty value of each item was then determined by finding the number of students answering the item correctly. As the total number of students were 200, the facility value obtained by multiplying the number of students attempting items correctly by 105/200. This was given the percentage of the students answering each item correctly. Please refer Appendix-F for test along with direction and scoring key.

Preparation of Blue Print

A three dimensional blueprint showing coverage of contact, instructional objectives and types of items were prepared by referring the X standard text book of Biology, and in consultation with the guiding teacher senior lecturers of education and personal experience.
The objectives of the test were taken from Bloom's Taxonomy of Educational Objectives in Cognitive Domain. These are the following objectives:

1) Knowledge
2) Understanding
3) Application

'Knowledge' is considered by any of the following behaviours to recall, to recognize, to show information on charts and diagrams etc. without involving any substantive manipulative skills.

'Understanding' is to be considered by any of the following behaviours, to change, to classify, to distinguish, to explain, to identify, to illustrate, to indicate, to justify, to represent, to summarize, to transform, to translate, etc.

'Application' is to be considered by any of the following behavior, to assess, to construct, to demonstrate, to explain, to compute, to establish, to generate, to modify, to predict, to perform, to solve etc.

Table 3.6 : Showing the Blue Print

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Content</th>
<th>Knowledge</th>
<th>Understanding</th>
<th>Application</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Living World</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>The Study of the Cells</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>Micro Organisms</td>
<td>7</td>
<td>2</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>The Life Processes</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Food Production and Management</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>Environmental Science</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>The Evolution of Life</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>30</td>
<td>10</td>
<td>8</td>
<td>48</td>
</tr>
</tbody>
</table>

Table 3.7 : Showing the Objective-wise Weightage

<table>
<thead>
<tr>
<th>Objectives</th>
<th>No. of Questions</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>37</td>
<td>35.24%</td>
</tr>
<tr>
<td>Understanding</td>
<td>57</td>
<td>54.28%</td>
</tr>
<tr>
<td>Application</td>
<td>11</td>
<td>10.48%</td>
</tr>
<tr>
<td>Total</td>
<td>105</td>
<td>100%</td>
</tr>
</tbody>
</table>
Table 3.8: Showing the Question Type Weightage

<table>
<thead>
<tr>
<th>Type of Questions</th>
<th>Marks</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Choice</td>
<td>105</td>
<td>100%</td>
</tr>
</tbody>
</table>

Screening of Test Items

This was done with a view to retain one of the synonymous items and the items which could fit into the framework of the competency. Items which were vague were discarded and remaining items were edited to make it clear.

Writing of Directions

Suitable directions were given on the top of each item in each competency. Further, the mode of giving response to the various items to the competency was illustrated with specific example.

Try Out

Before construction of the test items, the investigator had done a thorough study of the methodology and objectives of biology. Initially 105 items were prepared. The test was tried out in 4 secondary schools in Coorg district. In order to administer the test, the cooperation of the school teachers was sought. The students were specifically given to understand that:
a) there was 30 minutes time limit for completing the test;
b) the scores of the test would be used only for research purpose; and
c) the honest and accurate answers of the students to test items would help the study in developing a reliable test in science. The test was administered to 200 students studying in IX standard.
Scoring

The test items were of objective type (multiple choice) questions. Therefore, one mark was awarded for each correct answer. Thus, the theoretical range of sum of scores was between 0-48. Sum of the item scores gave the scores on performance in science. The score of each student was calculated separately.

Item Analysis

Each test item was subjected to analysis in terms of: (I) Difficulty value, and (ii) Item Validity. For this purpose, the scores of all the 200 students taken for the try out were selected. The scores obtained by the students (n=200) were first arranged in the descending order. The two groups – 'high scoring' and 'low scoring', each composed of 27% i.e., 50 of the students of the sample 200, formed the basis for the computation of validity and difficulty indices.

For determining item validity, numerous indices and procedures were available. In the present study, the correlation approach i.e., correlating the item score with the test score was followed. For computing item test correlation the 'point-biserial correlation method' (Guilford, 1954, p. 427) was used. The choice of this method was based on two considerations: (i) one of the variables, namely, item score is in the form of genuine dichotomy (1 or 0); (ii) Labour saving 'abac' is developed by Flanagan for determining estimates of pbis.

The difficulty value of each item was determined by using the formula.

$$D = \frac{U+L}{2}$$
Where

\[ D = \text{difficulty value of the item} \]
\[ U = 27 \text{ percentage of students scoring the item correctly in the upper or higher scoring group; and} \]
\[ L = 27 \text{ percentage of students scoring the item correctly in the lower of low scoring groups} \]

The difficulty values of the test items are shown in Appendix-H.

**Reliability of the Scientific Aptitude**

1) **Coefficient of Stability**

The coefficient of stability of the science achievement test was determined by the test-retest method. For this purpose the achievement test was re-administered to a random sample of 200 students involved in the first try out two weeks after the first administration. Then correlation between the test and retest scores was computed. The coefficient of correlation between the two sets of scores on the science achievement test was found to be 0.2816, which is quite significant at 0.05 level. This implies that the science achievement test has stability and reliability.

2) **Coefficient of Consistency**

The coefficient of consistency of the achievement test was determined by the split-half method. For this purpose scores obtained on the achievement test to the 200 students involved. The total scores were divided into two halves – one relating to odd numbered items and the other to even numbered items. The obtained coefficient of correlation between the scores on the halves was corrected for full length of achievement test by means of Spearmen Brown prophecy formula (Garrett, 1966, p. 339). The coefficient of
consistency of the science achievement test was found to be 0.7423 for full length of the scale, which is significant at 0.05 level. This implies that the science achievement test has consistency reliability. Please see Appendix-F₃ for computation of consistency coefficient of achievement test in science.

Validity of the Scientific Aptitude Test

1) Intrinsic Validity

Intrinsic validity of the scientific aptitude test was computed from its reliability coefficients (Guilford, 1954, p. 399). The range of validity coefficient was between 0.6410 and 0.6619, which indicates the intrinsic validity of the test.

2) Content Validity

Three teachers of secondary schools teaching science acted as judges and collected opinion from the three B.Ed. college lecturers of physics in establishing content validity of the science achievement test. The judges were fully satisfied with the relevance of the test items and the scoring procedures. They were also satisfied with the adequate coverage of content of biology at IX standard. This implies that the scientific aptitude test in biology is comprehensive and relevant.

3) Concurrent Validity

Concurrent validity of the scientific aptitude test was computed by taking relationship between classroom test scores and scientific aptitude test scores and the concurrent validity of the test was found to be 0.2148, which is found to be significant at 0.05 level. Please refer Appendix-F₄ for computation of concurrent validity.
Final Tool

Items with 100 percent and 0 percent difficulty value and items with less than 0.25 validity coefficient were deleted (Thorndike, 1966, p. 245). As a result of the first analysis – determination of ‘C’ values and as a result of the second analysis – determination of ‘Y’ values out of the total number of 105 items, constructed by the investigator, 32 items were 57. The final tool consisted of 48 items in all. The directions for using the test were found to work well and were maintained without any modification (See Appendix-F1 for pre and final version of the scientific aptitude test along with directions and key answer sheet).

3.10 Data Collection Procedure

The investigator contacted the authorities of the proposed and selected schools for testing. The tests were conducted during 2005-2006. The investigator personally visited all the schools and sought the cooperation of the school authorities, teachers and heads of the schools etc., The schools cooperated by assigning teachers for helping the investigator in conducting the testing and also by adjusting the school work to suit the convenience of testing. The investigator followed all the directions given in the respective test manuals for administering the different tests.

Uniform procedure was observed in administering the tests in different schools. Investigator gave a short explanation of the aim and scope of the study to the subjects in order to get their effective participation in test taking. The following steps were taken invariably followed in all the test sections.

- Distribution of the answer sheets with instructions for filling them up.
- Distribution of test booklets with necessary instructions.
• Explaining the general directions in the booklets.
• Making the students familiar with the answer sheets, mode of entering responses etc.
• Clearing the doubts of subjects.
• Each test session started with the instruction ‘START’, the commencement was noted on a stop watch and the test session was closed with the instruction ‘STOP’ when the time limit for each test was over, as shown in the stop watch. This was followed by the collection of the booklets and filled up answer sheets. The things were strictly observed.

The completion of the entire test required about 30 minutes. To minimize the fatigue of long testing, the testing was done in four phases.

The selection of class division was left to the authorities of the schools concerned with specific directions given to them as the exact requirement of the samples.

**Scoring and Consolidation of Data**

All the score sheets were scored using scoring keys provided with the test manuals. Since, all the tests contained only objective items. Each correct answer was assigned 'One' score and wrong answer a 'Zero' score. The scores of each individual was found out and entered on the score sheet in the space provided for the same.

**3.11 Statistical Techniques Used**

1) **Descriptive Statistics**

Descriptive statistics, such as mean and standard deviation, t-test, were used to study the significant difference among the mean scores of the groups.
2) Correlation Analysis

Correlation Analysis was also used to investigate the correlation or relationship between independent variables with dependent variables. Pearson's correlation coefficient technique was applied and simple relationships were obtained.

3) ANOVA

ANOVA test and 't' test were applied to investigate the significant, non-significant relationships among the variables.

4) Regression Analysis

Regression Analysis was used to reveal the degree to which each independent variables on the corresponding dependent variables.

5) Path Analysis

Path Analysis was also used to find the direct and indirect effects of independent variables on the corresponding dependent variables.

All the statistical techniques were carried out by using SPSS 11.0 statistical software.

3.12 Limitations of the Study

The present study has some following limitations:

- The present study is limited to only English medium schools from textbook of IX standard Biology and written Lesson Plans accordingly prescribed by DSERT, Bangalore.
- Thirty six concept maps were only developed for administration.
- The conventional method of teaching is followed in the study.
- The study is limited only to Biological Science of IX standard.
- Rural and urban, male and female were only the personal variables considered in the study.
• The study is having a scope for only the IX standard students 2006-07.
• The study is considered only to the independent variable like cognitive ability, problem solving ability and scientific aptitude.