CHAPTER –III
DESIGN OF THE STUDY AND METHOD OF INVESTIGATION

3.1 INTRODUCTION
Research methods describe the various steps of the plan of action to be adopted in solving the research problem, such as the manner in which the problem is formulated, the definition of terms, the choice of subjects for investigation, the validation of data gathering tools, collection of data, analysis and interpretation of data and the process of inferences and generalizations.

3.2 NEED AND SIGNIFICANCE OF THE STUDY
In human life, science plays a significant role. Man cannot imagine life without science, because it is intertwined in his body. It is through science that people develop an understanding of the world around them and make discoveries. The teaching of science is still challenging because of its abstract, complex and theoretical nature. To improve students’ understanding of the complex processes involved in science, teachers should incorporate certain elements into their lessons.

A thinking person is of his/her behaviour. He/she determines when it is necessary to use metacognitive strategies. He/She selects strategies to define a problem situation and researches on an alternative solution. He/She monitors, controls and judges his/her thinking.

Experimental evidence of the studies carried out by Zarkaria, 2007; Lin, 2008; Sabin, 2009; Ibe, 2009; Pulmones, 2009; Gulsum, 2010 support the notion that instruction in metacognitive strategies are associated with best performance. Metacognition would be regarded as an intermediate step to proficiency embedded in ongoing thinking and
problem solving. It is particularly important for new knowledge mastery, to have awareness of strategies, initial teaching skills and to judge task difficulty and effort.

The opportunity for students to engage in metacognitive thought can easily be integrated into any lesson. By simply asking a student to explain their thought processes. Therefore, a teacher can effectively improve students’ ability to complete similar activities in the future. For creating metacognitive environment, teachers should monitor and apply their knowledge and also deliberately mould metacognitive behaviour to the students. Teachers need to focus students’ attention on how tasks are accomplished. Process goals in addition to content goals, must be established and evaluated by students. So that they can discover the understanding and transferring thinking processes which improve learning.

The investigator personally interacted and interviewed with selected higher secondary students in the schools and teachers, to know their level of metacognitive awareness. Based on the interaction and the interview, it was found that their knowledge level in metacognition and the strategies present in it are very poor. In the conventional classroom, surface approaches to learning are very common. Most students adopted a surface approach to learn in terms of attending classes, reviewing notes and doing exercises. The students are the passive recipient of the information already acquired by the teacher. Most conventional biology classes aim to make mastery of the text-book, to complete text-book assignments and examination orientated.

Since the students are taught using chalk and talk method, the students are not able to get aware of better knowledge in learning biology, which in turn affects the attitude towards learning biology. Due to this factor the awareness towards gaining knowledge in metacognition is also decreasing among them.
As stated earlier, and the researchers also indicated that conventional instruction method is not effective among many students at higher secondary level (Ponnusamy, 2006; Saravanakumar and Mohan, 2007; Ibe, 2009). The investigator felt the need for developing metacognitive strategies which provides opportunity to the learners to think about their thinking, which in turn helps them to attain the higher order cognition level. Therefore, the investigator has developed “Metacognitive strategy model in biology to enhance the achievement of students in biology”.

Home is considered as a first school for every individual and it is one of the basic elements in the society. Hence the environment of home plays vital role on the development of every individual in sociological and psychological perspectives. The performance and the achievement of every child depend on the environment given by the parents at home to their wards. Considering the importance of the environment of home, the investigator has included “Home Environment” as one of the influencing sociological factor in the study.

For attitude plays a vital role among individuals. To create interest towards learning, attitude has its own role. If the attitude is positive, there will be better learning takes place otherwise there will not be a chance of learning. Hence attitude towards learning any concept or subject plays significant role. Therefore the investigator has included another psychological factor, i.e. Attitude Towards Learning Biology among higher secondary students.

Finally, the investigator aims to measure the achievement of higher secondary students in biology, using metacognitive strategy model in biology with home environment as sociological factor, attitude scale on learning biology as psychological factor and metacognitive awareness as cognitive factor. Hence, the study not only concentrates on developing the metacognitive strategies in Biology and its effectives, but
also aims to study the other intervening factors of learning biology among higher secondary students.

3.3 SCOPE OF THE STUDY

The findings of this study will be an immense help for the educationists particularly for the teachers and students to know the usefulness of the approach. i.e. Metacognitive Strategies in learning Biology. The concept of education has been changed from time to time; the teaching methods and techniques should also be changed in accordance with the changing system itself. It mainly helps the teachers and students to make their teaching-learning process easier. The findings of the study will create an awareness among the academician to improve the method of biology teaching and learning.

3.4 STATEMENT OF THE PROBLEM

Biology is an essential discipline because of its practical role to the individual and society. It is the responsibility of the biology teachers to inculcate the values of biology. Biology concepts are closely associated with cognition. If metacognitive skills are developed through cognitive processes, the students can construct his or her own knowledge and can develop improved capabilities in learning knowledge and skills, analyzing data and resolving problems independently. So the investigator intends to develop innovative and effective metacognitive strategies for teaching and learning biology in the classroom through experimental study in order to enhance the level of achievement among higher secondary students. Hence the problem for the present study is stated as

Effectiveness of Metacognitive Strategies in Biology Among Higher Secondary Students.
3.5 OPERATIONAL DEFINITION OF THE KEY TERMS

Effectiveness

The investigator refers “Effectiveness” as the positive effect of metacognitive strategy model in biology on achievement of higher secondary students.

Metacognition

The investigator refers “Metacognition” as the process of monitoring and assessing learning process of higher secondary students by themselves.

Strategies

The investigator refers “Strategies” as the plan of actions designed to achieve the learning objectives by the higher secondary students.

Biology

The investigator refers biology as a subject of study prescribed for higher secondary students in Tamilnadu. The topics in standard XI biology text book i.e. *Integumentary System, Skeletal System, Respiratory System, Fungi, Algae and Bryophytes* are chosen in this study.

Higher Secondary Students

Students enter the higher secondary course after passing Secondary School Leaving Certificate (S.S.L.C) examination. It is a two year course. In this study, the investigator has chosen standard XI students as sample for the study.
3.6 OBJECTIVES OF THE STUDY

The following objectives are formulated

i. To develop a metacognitive strategy model in Biology for standard XI students.

ii. To find whether there is any significant difference among control group, experimental group1 i.e. IBLMG and experimental group2 i.e. CLMG in metacognitive awareness of higher secondary students.

iii. To find whether there is any significant difference among control group, IBLMG and CLMG in attitude towards learning biology of higher secondary students.

iv. To find whether there is any significant difference among control group, IBLMG and CLMG in home environment of higher secondary students.

v. To find whether there is any significant difference among control group, IBLMG and CLMG in pre-test scores of higher secondary students.

vi. To find whether there is any significant difference among control group, IBLMG and CLMG in post-test scores of higher secondary students.

vii. To find whether there is any significant difference among control group, IBLMG and CLMG in gain scores of higher secondary students.

viii. To find whether there is any significant difference among control group, IBLMG and CLMG in gain scores on attainment of objectives: knowledge, understanding and application of higher secondary of students.

ix. To find whether there is any significant difference among control group, IBLMG and CLMG in retention test scores of higher secondary students.

x. To find whether there is any significant relationship between home environment and attitude towards learning biology of higher secondary students among control group, IBLMG and CLMG.
xi. To find whether there is any significant relationship between home environment and metacognitive awareness of higher secondary students among control group, IBLMG and CLMG.

xii. To find whether there is any significant relationship between metacognitive awareness and attitude towards learning biology of higher secondary students among control group, IBLMG and CLMG.

xiii. To find whether there is any significant influence of home environment on gain scores of control group, IBLMG and CLMG.

xiv. To find whether there is any significant influence of metacognitive awareness on gain scores of control group, IBLMG and CLMG.

xv. To find whether there is any significant influence of attitude towards learning biology on gain scores of control group, IBLMG and CLMG.

xvi. To find whether there is any significant influence of metacognitive awareness, attitude towards learning biology and home environment on gain scores of higher secondary students among control group, IBLMG and CLMG.

3.7 HYPOTHESES

The following hypotheses are formulated based on the above objectives.

i. There is no significant difference among control group, IBLMG and CLMG in metacognitive awareness of higher secondary students.

ii. There is no significant difference among control group, IBLMG and CLMG in attitude towards learning biology of higher secondary students.

iii. There is no significant difference among control group, IBLMG and CLMG in home environment of higher secondary students.

iv. There is no significant difference among control group, IBLMG and CLMG in pre-test scores of higher secondary students.
v. There is no significant difference among control group, IBLMG and CLMG in post-test scores of higher secondary students.

vi. There is no significant difference among control group, IBLMG and CLMG in gain scores of higher secondary students.

vii. There is no significant difference among control group, IBLMG and CLMG in gain scores on attainment of objectives: knowledge, understanding and application of higher secondary students.

viii. There is no significant difference among control group, IBLMG and CLMG in retention test scores of higher secondary students.

ix. There is no significant relationship between home environment and attitude towards learning biology of higher secondary students among control group, IBLMG and CLMG.

x. There is no significant relationship between home environment and metacognitive awareness of higher secondary students among control group, IBLMG and CLMG.

xi. There is no significant relationship between metacognitive awareness and attitude towards learning biology of higher secondary students among control group, IBLMG and CLMG.

xii. There is no significant influence of home environment on gain scores of control group, IBLMG and CLMG.

xiii. There is no significant influence of metacognitive awareness on gain scores of control group, IBLMG and CLMG.

xiv. There is no significant influence of attitude towards learning biology on gain scores of control group, IBLMG and CLMG.
There is no significant influence of metacognitive awareness, attitude towards learning biology and home environment on gain score of control group, IBLMG and CLMG higher secondary students.

### 3.8 DESIGN OF THE STUDY

Experimental design is the blueprint of the procedures that enable the investigator to test hypotheses by reaching valid conclusions about relationships between independent and dependent variables (Best, 1997).

The design selected for the present study is Pre-test Post-test Equivalent – Groups Design with two experimental groups and one control group. The pre-test-post-test Equivalent- Groups design in this study has the following structure:

\[
\begin{align*}
R & \quad O_1 & \quad X & \quad O_2 \\
R & \quad O_3 & \quad X & \quad O_4 \\
R & \quad O_5 & \quad C & \quad O_6 \\
\end{align*}
\]

- $O_1$, $O_3$, $O_5$ - Pre-tests
- $O_2$, $O_4$, $O_6$ - Post-tests
- $R$ - Random assignments of sample to groups
- $X$ - Exposure of groups to an experimental treatment
- $C$ - Exposure of group to the control treatment

In this design pre-tests ($O_1, O_3, O_5$) and post-tests ($O_2, O_4, O_6$) are conducted before and after the experimentation. The design of the present study is shown below.
TABLE 3.1
DESIGN OF THE EXPERIMENT

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Experiment Group1</th>
<th>Experiment Group2</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pre-test (Achievement Test in Biology)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Inquiry based metacognitive strategies</td>
<td>Cooperative learning method based metacognitive strategies</td>
<td>Chalk and talk method</td>
</tr>
<tr>
<td>3</td>
<td>Post-test (Achievement Test in Biology)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Retention test (Achievement Test in Biology)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.9 SAMPLE

A sample is a small proportion of population selected for observation and analysis. A total of 105 girls studying standard XI in Municipal Girls Higher Secondary School, Tirunelveli town constituted the total sample. The investigator had randomly selected the sample.

3.10 CATEGORIZING THE SAMPLE INTO EQUIVALENT GROUPS

*Catell’s Culture Fair Intelligence Test* was conducted to split the sample into three equivalent groups. Based on the intelligent test score, they were categorized into Experimental group1 i.e. *Inquiry Based Learning Method Group (IBLMG)*, Experimental group2 i.e. *Cooperative Learning Method Group (CLMG)* and Control group. In this study the investigator has selected set of three individuals with identical or nearly
identical intelligent test scores and assigning one of them to IBLMG, another to CLMG and the remaining one to control group. So there were 35 students in each group as shown in table 3.2. To ensure the homogeneity of the group, the ANOVA among three groups were found which was not significant at 0.05 level. Hence these three groups are equivalent.

### TABLE 3.2
FORMATION OF THREE EQUIVALENT GROUPS

<table>
<thead>
<tr>
<th>Group</th>
<th>Sample Size</th>
<th>School</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBLMG</td>
<td>35</td>
<td>Municipal Girls Hr.Sec. School, Tirunelveli town.</td>
</tr>
<tr>
<td>CLMG</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Control group</td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>

### FIGURE 3.1
DISTRIBUTION OF THE SAMPLE

- Control group
- IBLMG
- CLMG
### TABLE 3.3
**DISTRIBUTION OF THE SAMPLE – DEMOGRAPHIC VARIABLES**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sub-categories</th>
<th>Control group</th>
<th>IBLMG</th>
<th>CLMG</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Achievement level</td>
<td>Low achievers</td>
<td>12</td>
<td>34.29</td>
<td>12</td>
<td>34.29</td>
</tr>
<tr>
<td></td>
<td>High achievers</td>
<td>23</td>
<td>65.71</td>
<td>23</td>
<td>65.71</td>
</tr>
<tr>
<td>Locality of Residence</td>
<td>Urban</td>
<td>23</td>
<td>65.71</td>
<td>24</td>
<td>68.57</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>12</td>
<td>34.29</td>
<td>11</td>
<td>31.43</td>
</tr>
<tr>
<td>Religion</td>
<td>Hindu</td>
<td>22</td>
<td>62.86</td>
<td>21</td>
<td>60.00</td>
</tr>
<tr>
<td></td>
<td>Muslim</td>
<td>10</td>
<td>28.57</td>
<td>9</td>
<td>25.71</td>
</tr>
<tr>
<td></td>
<td>Christian</td>
<td>3</td>
<td>8.57</td>
<td>5</td>
<td>14.29</td>
</tr>
<tr>
<td>Parents educational qualification</td>
<td>Illiterate</td>
<td>19</td>
<td>54.29</td>
<td>20</td>
<td>57.14</td>
</tr>
<tr>
<td></td>
<td>School Education</td>
<td>12</td>
<td>34.29</td>
<td>10</td>
<td>28.57</td>
</tr>
<tr>
<td></td>
<td>Graduate</td>
<td>4</td>
<td>11.43</td>
<td>5</td>
<td>14.29</td>
</tr>
<tr>
<td>Monthly income of the families</td>
<td>Below Rs.10000</td>
<td>21</td>
<td>60.00</td>
<td>21</td>
<td>60.00</td>
</tr>
<tr>
<td></td>
<td>Rs.10000-20000</td>
<td>10</td>
<td>28.57</td>
<td>8</td>
<td>22.86</td>
</tr>
<tr>
<td></td>
<td>Above Rs.20000</td>
<td>4</td>
<td>11.43</td>
<td>6</td>
<td>17.14</td>
</tr>
</tbody>
</table>

Students who are residing in the Tirunelveli city corporation limit are considered as urban students and not residing within corporation limit and living in villages are considered as rural students.

Those students who have failed in biology (scored below 35 out of 100) in quarterly examination in the school record are considered as low achievers. Remaining students are considered as high achievers.
FIG. 3.2

ACHIEVEMENT LEVEL OF THE SAMPLE

3.11 LOCATION OF THE SCHOOL

Figure 3.2 shows the map where the study was conducted i.e. Municipal Girls Hr. Sec. School, Tirunelveli town, Tamilnadu

FIGURE 3.3

MAP OF LOCATION OF THE SCHOOL

(Source: www.maps.google.co.in)
3.12 TOOLS USED IN THE STUDY

The instruments that are employed to gather new facts or to explore new fields are called tools. It is of vital importance to select suitable instruments or tools. The tools used for the present study were

i. Personal Data Form

ii. Metacognitive Strategies Model in Biology – *Developed by the investigator and Guide*(2012)

iii. Catell’s culture fair intelligence test – *Standardized tool*(1971)

iv. Achievement Test in Biology – *Developed by the investigator and Guide*(2012)

v. Metacognitive Awareness Scale – *Developed by the investigator and Guide*(2012)

vi. Attitude Scale Towards Learning Biology - *Developed by the investigator and Guide*(2012)

vii. Home Environment Inventory – *Developed by the investigator and Guide*(2012)

3.12.1 PERSONAL DATA FORM

This tool was prepared by the investigator to collect personal data such as community, religion, locality, educational qualification of parents and occupation of parents. The personal data sheet is appended (Appendix A).
3.12.2. DEVELOPMENT OF METACOGNITIVE STRATEGY MODEL IN BIOLOGY

From the dictionary meaning, model is a pattern of something to be made or reproduced and a means of transferring relationship or process from its actual setting to one in which it can be more conveniently studied. Accordingly, teaching is a plan or pattern that can be used to shape curricula to design instructional materials and to guide instruction in the classrooms and other settings. The most important aim of any model of teaching is to improve the learning, instructional effectiveness and to improve or shape the curriculum.

The development of a model in teaching/learning is the process of submitting an educational idea to repeated testing and refinement until the idea has matured to the point where fairly precise predictions can be made about how to use it and effects to be expected if it is implemented well (Ferrari et al. 1998).

The metacognitive strategy model is developed with a view to realizing the following goals.

i. Developing an alternative teaching methodology to replace the traditional lecture format.

ii. Creating a metacognitive thinking environment, which develops students’ awareness of thinking

iii. The opportunity for students to engage in metacognitive thought can easily be integrated into any lesson.

Hartman (2001) stated that “teaching for metacognition means that teachers will think about how their instruction will activate and develop their students' metacognition”.

Lin (2001) suggested that metacognitive instruction is effective only if it involves theory and practice. The learner must be given some knowledge of cognitive process as
well as opportunities to practice metacognitive strategies. Simply providing knowledge without experience does not seem to be sufficient for metacognitive development.

A thorough analysis of existing models of metacognition gave a clear idea regarding the key aspects and characteristics of a model. Then the biology syllabus at higher secondary level was analyzed. Textbooks, handbooks, reference books, method of teaching, examination system, pedagogical principles, etc., also were analyzed. Consultations with experts in the field of school education, metacognition and teacher education were made for framing the sequence of learning events. Teaching techniques, Metacognitive strategies and its process were identified to enhance achievement in biology of higher secondary students.

The present metacognitive strategy model is designed on the basis of the following steps

i) Identifying teaching techniques

ii) Identifying metacognitive components and its strategies

iii) Process to develop metacognitive behaviours

iv) Validation of the model

**i) Identifying Teaching Techniques**

After having gone through the various techniques suggested by the researchers in table 2.2, the technique for the present study was designed by the investigator. The investigator found that the *inquiry and cooperative learning methods* are the suitable method of using metacognitive strategies among higher secondary students. Hence *inquiry and cooperative learning methods* are implemented in the study. The model proposed by *Blakey and Spence(1990)* in problem solving was adopted by the investigator. After analysis, investigator has modified by including the following steps in the process stage. They are “Define what you know and what you do not know”, “Talk
about what you are thinking”, “Keeping a diary of thinking”, “Planning and self-control” , “Thinking process briefing” , “ Self-assessment”. These are included because a student must know the knowledge what he/she shows and do not must be able to discuss about the thinking process, maintaining a diary to explain about the thinking process must know to plan and control the thinking if it goes in wrong direction. Beyond the above mentioned aspect one must have the habit of assessing a self, wherever and whenever required. Hence the above mentioned steps are felt necessary in the thinking process for inclusion.

a. Inquiry Based Learning

King (1992) developed a set of metacognitive questions and prompts examining their effectiveness in metacognitive activities for problem solving. Pulmones (2009) examined the effects of metacognitive questions and found that the use of the metacognitive questions led to a greater amount of higher level metacognitive discussions within groups. Kanesa(2012) developed guided metacognitive questioning to examine the effect on learner metacognitive activities in science education.

In this study, the investigator conducted inquiry based learning by posing carefully drafted questions. Metacognitive questions were framed in terms of student responses. The students were asked to respond to the questions, which helped them to develop their higher level of thinking. Students engaged in discussions with the teacher in response to the teacher’s questions. But pivotal questions are planned in advance which give direction and thrust to the lesson and helped to accomplish the goal. Hartman(2001) stated that teaching with metacognitive strategies means that teacher will think about how their questions will activate and develop students’ metacognition.
b. Cooperative Learning

Lin(2002) stated that metacognitive instructions in cooperative group can enable students to move beyond the text, memorization of basic facts, and learning lower level skills. Kramarski(2004) emphasized that as learners, some of who might normally "turn out" or refuse to speak out in a traditional setting, become actively involved in the learning process through group interaction. This method results in cognitive restructuring leads to an increase in understanding of all students in a cooperative group.

ii) Identifying Metacognitive Components and its Strategies

The investigator has framed the metacognitive strategies with the following dimensions for the study. They are

i) Meta-memory

ii) Self-planning

iii) Self-monitoring

iv) Self-evaluation

v) Self-regulation

Metacognitive strategies for meta-memory, self-planning, self-monitoring, self-evaluation and self-regulation are discussed earlier in chapter-I.

iii) Process to Develop Metacognitive Behaviours

The investigator has formulated the following model to develop metacognitive behaviours among students. The model proposed by Blakey and Spence (1990) was modified and updated according to the suitability of the sample and design of the investigation by the investigator and Kanmani(2012).
a. Define what you know and what you do not know

Students determine their levels by asking themselves ‘What is my relevant information about the subject? ’ What do I know? What do I want to learn? What do I not know?

b. Talk about what you are thinking

This includes the loud thinking in the process of making plan or problem solving. This study can be performed in peer groups or in small groups, that one student assumes the role of a teacher. These students talk and ask questions by telling and making explanations and abstraction.

c. Keeping a diary of thinking

Students write their difficulties and interpretations about problems in the notebook. They also note the process and methods used to solve the problem. Thus, students have an idea about experience and methods of thinking.

d. Planning and self-control

It is students’ plan to control the process that is relevant to the subject that is going to be learnt. However, students must have earned some characteristics in advance such as adjusting time, identifying and using materials.

e. Thinking process briefing

This strategy covers, develops and uses the metacognitive thinking skills that the students acquired. It involves a three-step method. Primarily, the teacher needs to guide the students about how they gained information by thinking in class and how they took part in activities. In the next stage, students need to group ideas and define which thinking strategies they used, and in the final stage, students should evaluate their own achievements and make assessments about their election in relation to future strategies.
f. Self-assessment

It is the determination of the metacognitive skills of the students by the pre-prepared individual checklist in the form of assessment. Metacognitive strategies are the sequential processes used to provide control in learning and in reaching one’s goal. They help individuals significantly to make regulations and take control of their learning. For example, after reading a text, a student can query himself about the concepts discussed in the paragraph. This self evaluation is a monitoring metacognitive strategy and at this stage, the cognitive purpose of students is to understand texts. If a student fails to answer his/her own question, he/she must determine what he/she needs to perform his/her cognitive process.

iv) Validation of the model

The development of a model was the result of the joint effort of the investigator and the guide.

a. Expert Validation

It was given to the experts in the field of metacognition for opinion. The model was thus modified according to the suggestions given by them.

b. Individual try out

After completing the expert validation, pilot testing was done among students and teachers of the Municipal higher secondary school, Meenakshipuram, Tirunelveli Junction. Three teachers were selected to teach a higher secondary class using the model. Five high achieving students in biology were selected to learn the concepts using the model developed. Necessary corrections were incorporated as per the feedback given by the teachers and students.
c. Small Group Try out

The investigator implemented the model elements to the group of 30 students and 10 teachers in Municipal higher secondary school, Meenakshipuram, Tirunelveli Junction. The developed model was given to science teachers working in Municipal higher secondary school, Meenakshipuram, Tirunelveli Junction and to students. The science teachers were asked to teach the concept using the model. The same was given to the students to learn the biological concepts with the help of the teachers. The model was then updated and corrections were carried out according to the suggestions given by teachers. The required updation was made based on the learning experience gained by the students.

d. Large Group Try out

The investigator implemented the model elements among the students in (i) Government higher secondary school, Kalakad, (ii) Rose mary matriculation higher secondary school, Palayamkottai and (iii) M.D.T Hindu higher secondary school, Tirunelveli town. Their feedbacks were carefully examined and modifications were made as per their suggestions. Hence the model was found to be valid after validating using expert validation, individual try-out, small group try-out and large group try-out. Fig. 3.3 shows the metacognitive model on achievement in biology.
3.12.3 CATELL’S CULTURE FAIR INTELLIGENCE TEST

Catell’s culture fair intelligence test consisted of four sub-tests. They are series classification, matrices and condition. There are three scales present in it, but the investigator used scale2(Form A). A description of the subsets is given below:

Test1

In the first sub-test, the individual is presented with an incomplete progressive series of figures. His task is to select from the choices provided, the answers which best continues the series. The time taken for answering the test is three minutes.

Test2

In the classification sub-test, the individual is presented with five figures. One must select one, which is different from the other four. The time taken for answering the test is four minutes.

Test3

In the matrices sub-set, the test is to correctly complete the design or matrix presented at the left of each row. The time allotted for answering the test is three minutes.

Test4

The final sub-test, condition (Topology) requires the individual to select, from the five choices provided, the one which duplicated the condition given in the far left box. The time allotted for answering the test is four minutes. The scoring was done with the help of the manual given. Each correct response obtained is given one mark. Cattle’s Culture Fair intelligent test is appended (Appendix B)

The author has established the validity of the test as 0.84. The reliability of the test was found using split-half method and test-retest method and coefficient of reliability was found to be 0.76 and 0.73.
3.12.4 ACHIEVEMENT TEST IN BIOLOGY

The investigator has gone through the standard XI Biology text book of TamilNadu Government. The Integumentary System, Skeletal System, Respiratory System, Fungai, Algae and Bryophytes in standard XI text book are chosen as topics to be taught in the study.

a. Draft Test

For developing the draft test the investigator prepared multiple choice questions from the selected topic to make the test objective to the fullest extent. Due weightage were given to the content, objectives and difficulty level while preparing the test.

One hundred and ten items were prepared and scrutinized. Some items were deleted and some others were re-edited in the light of expert’s criticism. The number of items in the draft test was thus reduced to ninety eight.

b. Weightage to Content

The content was divided into 6 units and the marks are allotted according to the importance of the unit. The weightage given to the contents for the draft test is given in table 3.4

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Content</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Integumentary system</td>
<td>15</td>
<td>15.3</td>
</tr>
<tr>
<td>2</td>
<td>Skeletal system</td>
<td>16</td>
<td>16.3</td>
</tr>
<tr>
<td>3</td>
<td>Respiratory system</td>
<td>16</td>
<td>16.3</td>
</tr>
<tr>
<td>4</td>
<td>Fungai</td>
<td>18</td>
<td>18.4</td>
</tr>
<tr>
<td>5</td>
<td>Algae</td>
<td>17</td>
<td>17.3</td>
</tr>
<tr>
<td>6</td>
<td>Bryophytes</td>
<td>16</td>
<td>16.3</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>98</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
c. Weightage to Objectives

The three objectives: knowledge, understanding and application of the cognitive domain were tested in the achievement test. The weightage given to three objectives for the draft test is given in table 3.5

**TABLE 3.5**

**WEIGHTAGE TO OBJECTIVES**

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Objectives</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Knowledge</td>
<td>23</td>
<td>23.4</td>
</tr>
<tr>
<td>b.</td>
<td>Understanding</td>
<td>47</td>
<td>47.9</td>
</tr>
<tr>
<td>c.</td>
<td>Application</td>
<td>28</td>
<td>28.6</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>98</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

**d. Weightage to Difficulty Level**

The achievement test in biology was constructed according to the level of difficulty such as easy, average and difficult. The table 3.6 shows the percentage of weightage given to the questions in the draft test.

**TABLE 3.6**

**WEIGHTAGE TO DIFFICULTY LEVEL**

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Difficulty level</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Easy</td>
<td>28</td>
<td>28.6</td>
</tr>
<tr>
<td>2</td>
<td>Average</td>
<td>46</td>
<td>46.9</td>
</tr>
<tr>
<td>3</td>
<td>Difficult</td>
<td>24</td>
<td>24.5</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>98</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
e. Blue print

The blue print is a document that gives a complete picture of the test. It shows the distribution of questions and marks assigned for different objectives. It helps the test constructor to prepare appropriate questions to suit the purpose of test construction. Then the blue print was prepared showing the distribution of questions and scores for different objectives: knowledge, understanding and application. The table 3.7 shows the blue print of draft achievement test. The draft form of achievement test is appended (Appendix C)

**TABLE 3.7**

**BLUE-PRINT OF THE ACHIEVEMENT TEST IN BIOLOGY (DRAFT FORM)**

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Objectives</th>
<th>Difficulty level</th>
<th>Knowledge</th>
<th>Understanding</th>
<th>Application</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>E</td>
<td>A</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>1</td>
<td>Integumentary system</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Skeletal system</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Respiratory system</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Fungai</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>Algae</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>Bryophytes</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>7</td>
<td>16</td>
<td>10</td>
<td>7</td>
<td>13</td>
</tr>
</tbody>
</table>

f. Pilot study

The achievement test was administered among the students of standard XI in the schools mentioned in table 3.8. The investigator administrated the test with the help of the teachers in ideal condition. Sufficient time was given so as to enable the students to complete the test. The scoring was done according to the scoring key prepared by the investigator. The answer key for draft form of achievement test is appended in appendix D.
TABLE 3.8
DETAILS OF THE SAMPLE SELECTED FOR PILOT STUDY

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Name of the school</th>
<th>Type</th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Government Higher Secondary school, Barkit nagar, Palayamkottai</td>
<td>Govt</td>
<td>16</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Rosemary matric higher Secondary school, KTC nagar, palayamkottai</td>
<td>Private</td>
<td>5</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>MDT Hindu Higher Secondary school, Tirunelveli.</td>
<td>Govt. Aided</td>
<td>11</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>32</td>
<td>28</td>
<td>60</td>
</tr>
</tbody>
</table>

g. Item analysis

It is the process of establishing the suitability of a question for inclusion in the final test. The quality of each item was ascertained by analyzing two important characteristics of the items namely (i) Difficulty index and (ii) Discriminating value.

The scores are arranged in descending order based on the marks in the achievement test. The scores obtained by the first 27% of the sample are considered as upper group, and the last 27% of the sample are considered as lower group. Then the responses given by the individuals for each item are tabulated.

The items are evaluated with the help of difficulty index and discrimination value. Items which are having difficulty index between 40 to 60 and discrimination value 0.4 and above are retained and other items are discarded. The difficulty index and discriminating value of the items in the achievement test in biology (draft) are given in appendix E.
h. Final Form of Achievement Test in Biology

The final form of achievement test in Biology contained 75 items which should be answered in 90 minutes. The blue print of the final form of achievement test in biology is given in Table 3.9. The final form of achievement test is appended in Appendix F.

TABLE 3.9
BLUE-PRINT OF THE ACHIEVEMENT TEST IN BIOLOGY (FINAL FORM)

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Objectives</th>
<th>Difficulty level</th>
<th>Knowledge</th>
<th>Understanding</th>
<th>Application</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>E A D</td>
<td>E A D</td>
<td>E A D</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Integumentary</td>
<td>2 2 2</td>
<td>1 1 1</td>
<td>1 2 1</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Skeletal system</td>
<td>1 2 1</td>
<td>1 2 1</td>
<td>1 2 1</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Respiratory system</td>
<td>1 2 1</td>
<td>1 1 1</td>
<td>1 2 1</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Fungai</td>
<td>1 2 1</td>
<td>2 2 1</td>
<td>1 2 1</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Algae</td>
<td>1 2 2</td>
<td>1 2 1</td>
<td>1 2 1</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Bryophytes</td>
<td>1 2 1</td>
<td>1 2 2</td>
<td>1 2 1</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>7 12 8</td>
<td>7 10 7</td>
<td>6 12 6</td>
<td>75</td>
<td></td>
</tr>
</tbody>
</table>

i. Establishing Validity of Achievement Test in Biology

Content validity

The content validity of the test was assured while preparing the blue print and giving adequate weightage to content and objectives. The opinion of experts in the field of education was taken into consideration while preparing the test and necessary modification were made according to their suggestions.
**Criterion-reference Validity**

It was calculated by correlating the scores of the test with marks of biology of students in the standard XI quarterly examination and the co-efficient of correlation obtained was 0.74. This value ensures the empirical validity of the test.

**j. Scoring procedure**

For each multiple choice questions, four choices of answers were given i.e. a, b, c, d. One mark was given to each correct answer. No negative marking was given to the wrong answers. The maximum marks for the test is 75 and minimum is 0. The answer key for final form of achievement test in biology is given in appendix G.

**3.12.4 METACOGNITIVE AWARENESS SCALE (MAS)**

In designing metacognitive awareness scale, initially studies of metacognition and standardized instruments for assessing metacognition were reviewed (*Schraw.et.al (2004), Kleitman.et.al. (2007), Surya.et.al.(2008), Young.et.al (2008), Emrri(2009))*. First, domains of metacognitive skills were identified based on previous instruments. They are meta-knowledge, self-planning, self-monitoring, self-evaluation and self-regulation.

Items were prepared after referring the literature related to metacognitive awareness and on consultation with the supervising teacher. Experts’ opinion were considered to find out the weakness and work ability of the items. The statements were modified and rewritten based on the opinion of the experts. Thus the draft form of the inventory contained 60 items was prepared. The distribution of items in the scale (draft) is presented in table 3.10. The draft form of metacognitive awareness scale is appended in Appendix H.
### TABLE 3.10
**DISTRIBUTION OF ITEMS IN METACOGNITIVE AWARENESS SCALE**
**(DRAFT FORM)**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Dimension</th>
<th>Number of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>Meta-memory</td>
<td>10</td>
</tr>
<tr>
<td>ii.</td>
<td>Self-planning</td>
<td>10</td>
</tr>
<tr>
<td>iii.</td>
<td>Self-monitoring</td>
<td>10</td>
</tr>
<tr>
<td>iv.</td>
<td>Self-evaluation</td>
<td>15</td>
</tr>
<tr>
<td>v.</td>
<td>Self-regulation</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>60</strong></td>
</tr>
</tbody>
</table>

**a. Pilot study**

The draft form of the scale was administered to randomly selected 60 higher secondary students with due representation to all sub sample. Clear instructions were given to them. They were asked to respond to each statement by choosing either *true* or *false*. The maximum time to answer the scale was 45 minutes.

**b. Establishing validity of MAS**

The content validity of the present scale was established by systematically analyzing the components under study. On the basis of the opinion of experts in education, 10 items were removed. It was ensured that the MAS covers various aspects of metacognition in-depth and also be used to obtain scores for individual areas of metacognition.

**c. Establishing reliability of MAS**

In the present study the reliability coefficient of the metacognitive awareness scale was calculated using the test-retest method. The inventory was administrated to 45 students two times at an eight weeks’ time interval and the consistency between results were analyzed. The coefficient of correlation between the two scores was found to be 0.79. Thus the tool was found to be highly reliable.
d. Final Form of Metacognitive Awareness Scale (MAS)

The final form of the MAS consisted of 50 items in five dimensions namely Meta-memory (8 items), Self-planning (9 items), Self-monitoring (6 items), Self-evaluation (13 items), and Self-regulation (14 items). The final form of MAS is appended (Appendix I).

e. Scoring

The presence or absence of behaviour is marked as true or false. The score for the presence is '1' and the absence is '0'. The total possible score of this questionnaire range from 0-50.

3.12.5 ATTITUDE SCALE TOWARDS LEARNING BIOLOGY (ASTLB)

Attitude scale towards learning biology was designed by investigator and guide. Before preparing ASTLB, the investigator reviewed the literature (Schibeci.1984; Osborne.et.al.2003; Sawtelle.et.al.2009; Kogee.et.al.,2006). The ASTLB was constructed by following the Likert’s method. Initially 50 statements were prepared. According to Indian context and at higher secondary student’s level the investigator made necessary modifications under the guidance of the experts. Some questions are discarded based on the suggestion given by experts. The number of items in the draft scale was thus reduced to 36. 18 statements (50%) were of positive statements and the remaining 18 statements (50%) were of negative statements. The draft form of ASTLB is given in appendix J. This ASTLB was administered among the sample and respondents were instructed to mark their agreement or disagreement with the decision on five point scale i.e strongly agree, agree, undecided, disagree and strongly disagree. The scoring was done which is shown in the table 3.11
TABLE 3.11
ASTLB (DRAFT FORM) SCORING TABLE

<table>
<thead>
<tr>
<th>Statements</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Negative</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

a. Pilot study

The draft scale was administered to randomly selected 60 higher secondary school students. Clear instructions were given to them to respond to the scale. They were requested to choose any one of the 5 opinions (strongly agree, agree, undecided, disagree and strongly disagree) relating to each item. Responses were scored as 5-1 from “strongly agree” to “strongly disagree” for positive items and 1-5 from “strongly disagree” to “strongly agree” for negative items. The scores of the individual statements were summated to arrive at the total score.

b. Validation procedure

The standardisation of the attitude scale towards learning biology was done using Likert item analysis. For the purpose of item analysis the responses of 60 students were considered. The scores of the students were arranged in the decreasing order. For determining the validity of items, the highest 27% and lowest 27% of the marks are selected. In evaluating the responses of the high and low groups to individual statement ‘t’ values of their mean responses to each statement was computed. ‘t’ value of about 1.75 indicates that the average responses of the high and low group to a statement differs significantly provided n=25. The items with a ‘t’ value of 1.75 and above were selected. The ‘t’ value of the statements are given in appendix K.
c. Final Form of ATLBS

The final form of ATLBS contained 30 items of which 18 are positive statements and 12 are negative statements. The distribution of positive and negative statements is presented in table 3.12. Hence minimum and maximum possible score ranges from 30 to 150.

TABLE 3.12
NUMBER OF POSITIVE AND NEGATIVE STATEMENTS IN ASTLB (FINAL FORM)

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Statements</th>
<th>Items wise Serial No</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>Positive</td>
<td>1,2,3,4,5,9,12,14,18,20,21,22,23,24,25,28,29,30</td>
</tr>
<tr>
<td>ii</td>
<td>Negative</td>
<td>6,7,8,10,11,13,15,16,17,19,26,27</td>
</tr>
</tbody>
</table>

d. Establishing validity of ASTLB

Content validity was found out to ensure the validity of the ATLBS. The tool was submitted to a panel of experts in the Colleges of Education and teacher's in higher secondary schools. All the experts have agreed with the statements in the tool. Thus the content validity of the tool has been established based on expert analysis and judgment.

f. Establishing reliability of ASTLB

In the present study the reliability coefficient of the ATLBS was calculated using test-retest method. The scale was administered to 45 students two times at an eight weeks’ time interval and the consistency between results were analyzed. The correlation value between the two scores was found to be 0.85. Thus the tool was found to be highly reliable. The final form of inventory is given in appendix L.
3.12.7 HOME ENVIRONMENT INVENTORY (HEI)

The Home Environment Inventory (HEI) is an instrument designed to measure the psycho-social climate of home as perceived by children. HEI has ten dimensions. The ten dimensions are Control, Protectiveness, Punishment, Conformity, Social isolation, Reward, Deprivation of privileges, Nurturance, Rejection and Permissiveness. In the present study, investigator has found the following four dimensions i.e. Protectiveness, Conformity, Nurturance and Permissiveness as the type of home environment existing among the sample. Operational definitions of these dimensions are as follows:

A. PROTECTIVENESS: It implies “Prevention of independent behaviour and prolongation of infantile care”.

B. CONFORMITY: It indicates “Parent’s directions, commands, or orders with which child is expected to comply by action”. It refers to “Demands to work according to parent’s desires and expectations”.

C. NURTURANCE: It indicates “Existence of excessive unconditional physical and emotional attachment of parents with the child. Parents have a keen interest in and love for the child”.

D. PERMISSIVENESS: It includes “Provision of opportunities to child to express his views freely and act according to his desires with no interference form parents”.

The investigator prepared 40 statements. Each dimension has ten items belonging to it. The draft form of HEI is appended in appendix M. The instrument requires pupils to tell the frequency with which a particular parent-child interaction behaviour has been observed by them in their homes, i.e. he/she is requested to tell whether a particular parental behaviour (as mentioned in an item) occurs - ‘Always’, ‘Often’, ‘Sometimes’, ‘Rarely’, and ‘Never’.
a. Pilot study

The draft scale was administered to randomly selected 60 secondary school students by giving due representation of all sub samples. The students were asked to respond to each item by putting a tick (✓) against the entries of a five point scales always, often, sometimes, rarely and never. The weightage assigned are 5, 4, 3, 2 and 1 for the responses always, often, sometimes, rarely and never respectively for each item.

b. Item analysis

Item analysis was done for the items in the tool. The scores of the students are arranged in descending order. The first 27% of arranged cases are considered as upper group. The last 27% of arranged cases is considered as lower group. The ‘t’ values of low and high group individual’s mean responses to each statement was computed. ‘t’ value of about 1.75 indicated that the average responses of the high and low group to a statement differs significantly provided n=25. The items with a ‘t’ value of 1.75 and above were selected. Hence 14 items were removed from the tool. The ‘t’ value of the statements are given in appendix N.

c. Final Form of HEI

The final form of HEI consisted 26 items in five dimensions namely Nurturances (7 items), Conformity(6 items), Permissiveness (8 items), and Protectiveness (5 items). The distribution of items in the inventory is presented in table 3.13. The final form HEI is appended (Appendix O).

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Dimensions</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>Nurturance</td>
<td>1-7</td>
</tr>
<tr>
<td>ii</td>
<td>Conformity</td>
<td>8-13</td>
</tr>
<tr>
<td>iii</td>
<td>Permissiveness</td>
<td>14-21</td>
</tr>
<tr>
<td>iv</td>
<td>Protectiveness</td>
<td>22-26</td>
</tr>
</tbody>
</table>

TABLE 3.13
DISTRIBUTION OF ITEMS IN HEI (FINAL FORM)
d. Establishing validity of HEI

Content validity was found to ensure the validity of the HEI. The tool was submitted to a panel of experts in the Colleges of Education and teacher's in higher secondary schools. All the experts have agreed with the statements in the tool. Thus the content validity of the tool has been established based on expert analysis and judgment.

e. Establishing reliability of HEI

The investigator has used test-retest method for establishing reliability of the tool. The tool was given to higher secondary students and their responses are valuated. After one month time, the same tool was given to the same sample their responses were scored. The correlation coefficient was found and it was found to be 0.78. Hence the HEI was found highly reliable.

3.13 SELECTION OF TOPICS

The topics for treatment in the present study were selected from the syllabus of Biological science prescribed for standard XI of Tamilnadu State Board from the academic year 2004-05. Before the selection of topics, the curriculum, syllabus, the text book, hand book and the course book prescribed for standard XI were studied carefully. In addition, necessary details regarding the topics were sought from experts and teachers concerned. Hence the investigator has selected three topics in zoology and three topics in botany. The topics are Integumentary system, Skeletal system, Respiratory system, Fungi, Algae and Bryophytes which were found suitable for the study.

All lessons were examined with great care and found amenable to be transacted through the metacognitive strategies and conventional method i.e. chalk and talk method of teaching. For the experimental groups, six separate lesson transcripts were prepared for IBLMG and CLMG each having time duration of ninety minutes. six lesson transcripts were prepared for the intervention of control group using chalk and talk method of
teaching. The topics selected for treatment and the objectives set for each learning topic were same for the experimental and control group. The objectives of the learning topics are as follows

**Learning topic 1: Integumentary system**

i. To understand the structure of skin

ii. To analyse the epidermis and dermis

iii. To understand the layers of skin

iv. To understand the structure of skin and skin colour

**Learning topic 2: Skeletal system**

i. To understand the arrangement of bones

ii. To know the uses of bones

iii. To identify the long bone and vertebra

iv. To understand the functions of bones

v. To understand the classification of bones

**Learning topic 3: Respiratory system**

i. To understand respiration process

ii. To know the organization of respiratory tracts

iii. To draw the structure of lungs

iv. To know the function of the respiratory tracts

v. To understand the function of the lungs

**Learning topic 4: Fungi**

i. To understand the characteristics of fungi

ii. To analyze the nutrition of fungi

iii. To draw the classification of fungi

iv. To know the economic importance of fungi
Learning topic 5: Algae

i. To analyse the salient features of algae

ii. To understand the distribution of algae

iii. To know the cell structure and pigmentation of the algae

iv. To understand the reproduction of algae

Learning topic 6: Bryophytes

i. To understand the characteristics of Bryophytes

ii. To analyse the alternation of generations

iii. To know the classification of Bryophytes

iv. To discuss the economic importance

3.14 LESSON TRANSCRIPTS FOR THE EXPERIMENTAL GROUPS

The lesson transcripts based on metacognitive strategies in research literature were referred (Lippmann, 2005; Saravakumar and mohan, 2007; Ramganesh, 2008; Ozsoy et al., 2009; Rajkumar, 2010). The lesson transcripts of the present study are designed by the investigator in consultation with guide. The prepared lesson transcripts were shown to researchers in metacognition and necessary modifications were done in the content. Metacognitive strategy proceeds through the following consecutive steps (Blakey and Spence, 1990).

Step 1 - Define what you know and what you do not know

Step 2 – Talk about thinking

Step 3 – Keeping the diary of thinking

Step 4 – Planning and self-control

Step 5 – Debriefing the thinking process

Step 6 – Self assessment.
During the execution of steps from step 1 to step 6, a work sheet containing metacognitive statements is given to all the students for reference. Students were asked to refer the statements in worksheet in the classroom. Metacognitive statements worksheet is given in appendix P. A model lesson transcript for IBLMG is given in appendix – Q and for CLMG is given in appendix R.

3.15 LESSON TRANSCRIPTS FOR CONTROL GROUP

Lesson transcripts for control group were prepared on the basis of the existing method followed. The method of instruction followed in the control group was chalk and talk method.

3.16 CONDUCTING THE EXPERIMENT

The schedule for all the activities of the experimentation i.e. handling classes and administering tools was given in table 3.14.

**TABLE 3.14**

**EXPERIMENTATION SCHEDULE - PHASEWISE**

<table>
<thead>
<tr>
<th>Phase</th>
<th>Control Group</th>
<th>IBLMG</th>
<th>CLMG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I</td>
<td>Catell’s culture fair intelligence test</td>
<td>Metacognitive Awareness Scale, Attitude Scale Towards Learning Biology, Home Environment Inventory and Pre-test (Achievement Test in Biology)</td>
<td></td>
</tr>
<tr>
<td>Phase II</td>
<td>Chalk and talk method</td>
<td>Inquiry based learning with metacognitive instructions</td>
<td>cooperative learning with metacognitive instructions</td>
</tr>
<tr>
<td>Phase III</td>
<td>Post-test (Achievement Test in Biology)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase IV</td>
<td>Retention test (Achievement Test in Biology) (After a time interval of 20 days)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Phase I

The investigator conducted the study after obtaining permission from the authorities of the school selected. The investigator randomly selected 105 students studying standard XI. Intelligence test was administered to the students. The scores are analysed to prove that means and standard deviations of the intelligence test scores of the students do not differ significantly. The students were classified into three groups (N=35) based on the marks obtained by the students in the intelligence test. They are (i) Control group (ii) Experimental group1 i.e. Inquiry Based Learning Method Group (IBLMG) and (iii)Experimental group2 i.e. Co-operative Learning Method Group (CLMG)

The tools metacognitive awareness scale, attitude scale towards learning biology, home environment inventory and pre-test (Achievement in Biology) were applied. The responses of the sample to all the tests were scored. The scores obtained by the students were used for further analysis.

Phase II

The investigator has gone through the standard XI Biology text book of Tamilnadu government. The topics Integumentary system, Skeletal system, Respiratory system, Fungai, Algae, Bryophytes were found suitable to teach the students through metacognitive strategies. The study consisted of three different treatments: chalk and talk method of teaching in control group, Metacognitive instructions based inquiry on IBLMG and Metacognitive instructions based cooperative learning in CLMG.

Control group

The control group was taught using chalk and talk method of teaching and the students are answering cognitive questions that were related to the material being taught. Students were asked to share the information with the entire class if they are so desired.
The teaching of students in this group was centered on the use of the textbook questions and assignments.

**IBLMG**

The investigator explained the need for developing metacognition in general and in the teaching learning process to IBLMG. After the lesson taught, the investigator conducted inquiry by asking questions related to material being taught. Metacognitive questions were framed in terms of student responses. The students were asked to respond to these questions with help of metacognitive statements worksheet, text-book and classmates. Adequate time was given to the students to think, to discuss, to note the learning points in their metacognitive statements worksheet, and to self evaluate the process and products of their own learning.

The investigator collected the metacognitive statements worksheet filled by the students after the class is over on each day to understand the extent of their metacognition. The investigator helped the low achievers to develop their metacognitive ability by means of informal discussions during the class hours and in free time.

**CLMG**

The investigator explained the need for developing metacognition in general and in the teaching learning process to CLMG. The investigator has carefully analyses the jigsaw cooperative learning method and modified the method. In jigsaw, the students are assigned different concepts to learn in the home group. The mastery group was formed by the students from the home group who have learnt the same concept. After that regrouping was done. To avoid the confusion in forming the groups thrice, the investigator has reduced the steps into two for formation of groups. i.e Basic groups and Mastery groups. In this method, the role of teacher is very important to facilitate their learning, after the formation of basic groups. Since the learning among basic group
members are taking place with the help of teachers, the learning is directed positively.

Therefore the investigator has modified the jigsaw cooperative learning method proposed by Aronson, Stephan, Sikes, Blaney and Snapp in 1978, was reduced into two steps according to the suitability of the topic and the subject chosen. Later on it was validated using individual try-out and small group try-out and large group try-out.

**Step1: Formation of Basic Group**

The students in the class are divided into 5 groups with equal number of students. In this study, the investigator divided the students into 5 groups, each one is called as *basic group* with 7 members. The topic to be learnt by the students was also divided into equal number of frame which is equal to the number of basic groups. The members in each group was allotted the same frame i.e. the concept to be learnt by all the members in the basic group. Each basic group is allotted different topics. But members in the each group will be learning the same concept. This provides an opportunity to the group members, to discuss about the concept to be learnt. The students will discuss about the topic for around 30 minutes. Likewise all the basic groups will be discussing about their topic for around 30 minutes. In case of any difficulties faced in learning the concept, the investigator facilitated the learning of the students for better understanding. Once all the group members were learnt the concept, the process of regrouping was done otherwise called *mastery group*. Since all the members in the group was identified using numbers, the member in the basic group1 is identified as a1, b1, c1, d1, e1, f1 and g1. The numbering of the members in each basic group is done as follows

<table>
<thead>
<tr>
<th>Group</th>
<th>Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Group2</td>
<td>a2, b2, c2, d2, e2, f2 and g2.</td>
</tr>
<tr>
<td>Basic Group3</td>
<td>a3, b3, c3, d3, e3, f3 and g3.</td>
</tr>
<tr>
<td>Basic Group4</td>
<td>a4, b4, c4, d4, e4, f4 and g4.</td>
</tr>
</tbody>
</table>
Basic Group 5: a5, b5, c5, d5, e5, f5, and g5

The grouping with allocation of frame is represented as follows.

**FIG. 3.5 STRUCTURE OF BASIC GROUP**

<table>
<thead>
<tr>
<th>Frame 1</th>
<th>Frame 2</th>
<th>Frame 3</th>
<th>Frame 4</th>
<th>Frame 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>g1</td>
<td>a1</td>
<td>f1</td>
<td>a4</td>
<td>a5</td>
</tr>
<tr>
<td>e1</td>
<td>b1</td>
<td>f2</td>
<td>f4</td>
<td>b5</td>
</tr>
<tr>
<td>c1</td>
<td>b2</td>
<td>e2</td>
<td>b4</td>
<td>c5</td>
</tr>
<tr>
<td>d1</td>
<td>c2</td>
<td>d2</td>
<td>c4</td>
<td>d5</td>
</tr>
</tbody>
</table>

**Step 2: Formation of mastery group**

The first member (a1) of each frame forms the mastery group 1, i.e., named as “A”. The second member of each frame forms the mastery group 2, i.e., named as “B”. Likewise, seven mastery groups are formed and it is named as A, B, C, D, E, and G. The pictorial representation of the formation of the mastery group from the basic groups, i.e., basic group 1 to basic group 5 is as follows.

**FIG. 3.6 STRUCTURE OF MASTERY GROUP**

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>a1</td>
<td>a5</td>
<td>b1</td>
<td>b5</td>
<td>c1</td>
<td>b1</td>
<td>a1</td>
</tr>
<tr>
<td>a2</td>
<td>a4</td>
<td>b2</td>
<td>b4</td>
<td>c2</td>
<td>b2</td>
<td>a2</td>
</tr>
</tbody>
</table>

**Step 3: Learning process**

Since the members in the mastery group (A to G) are from the five basic group, the member a1 in ‘A’ explain about the concept learnt in frame 1 to the other members in the group and other members were listen to him. Once it was explained, the second member a2 explain about the concept learnt in frame 2.

To the rest of the members in the mastery group 1 (A). Likewise the five frames will be learnt at mastery level on discussion with the members in the mastery group.
there is any need of clarification about the topic learnt, the mastery group are allowed to
discuss with the other mastery group members which is shown in fig.3.6.

**FIG.3.7. DISCUSSION AMONG MASTERY GROUPS**

![Diagram of Discussion Among Mastery Groups]

The investigator collected the metacognition awareness worksheet filled by the
students after the class on each day to understand the extent of their metacognition. The
teacher helped the low achievers to develop their metacognitive ability by means of
informal discussions during the class and in free time.

**Phase-III Administration of post-test**

Soon after the completion of Phase-II, the investigator conducted post-test
(Achievement Test in Biology). Post test was conducted to the three groups on the same
day under the supervision of the investigator. The response of the sample to the post test
was scored. The scores obtained after evaluation of the answer sheets were subjected to
statistical analysis.

**Phase-IV Administration of Retention test**

After the time interval of 20 days from the conduct of post-test the investigator
administered the retention test (using Achievement Test in Biology) to experimental
group1, experimental group2 and control group. The responses of the retention test were
scored and the scores were subjected to statistical analysis. The experimentation day
schedule is given in table 3.15. Fig. 3.7, Fig.3.8 and F.3.9 shows the photos taken during
experimentation.
## TABLE 3.15
### EXPERIMENTATION SCHEDULE - DAYWISE

<table>
<thead>
<tr>
<th>Day</th>
<th>SCHEDULE ON EXPERIMENTATION</th>
</tr>
</thead>
</table>
| Day 1 | Introduction in metacognition  
Catell’s culture fair intelligence test |
| Day 2 | CONTROL GROUP  
IBLMG  
CLMG  
| Metacognitive Awareness Scale,  
Attitude Scale Towards Learning Biology,  
Home Environment Inventory,  
Pre-test (Achievement Test in Biology) |
| Day 3 |  
Day 4 | Topic 1: Integumentary system  
Chalk and talk method  
Inquiry based learning with metacognitive instructions  
Cooperative learning with metacognitive instructions |
| Day 5 |  
Day 6 | Topic 2: Skeletal system  
Chalk and talk method  
Inquiry based learning with metacognitive instructions  
Cooperative learning with metacognitive instructions |
| Day 7 |  
Day 8 | Topic 3: Respiratory system  
Chalk and talk method  
Inquiry based learning with metacognitive instructions  
Cooperative learning with metacognitive instructions |
| Day 9 |  
Day 10 | Topic 4: Fungi  
Chalk and talk method  
Inquiry based learning with metacognitive instructions  
Cooperative learning with metacognitive instructions |
| Day 11 |  
Day 12 | Topic 5: Algae  
Chalk and talk method  
Inquiry based learning with metacognitive instructions  
Cooperative learning with metacognitive instructions |
| Day 13 |  
Day 14 | Topic 6: Bryophytes  
Chalk and talk method  
Inquiry based learning with metacognitive instructions  
Cooperative learning with metacognitive instructions |
| Day 15 | Post-test (Achievement Test in Biology) |
| Day 35 | Retention test (Achievement Test in Biology) |
3.17 STATISTICAL TECHNIQUES USED IN THE STUDY

The following statistical techniques were used by the investigator for analyzing the data.

i) Mean

Mean is the simplest measurement of central tendency of the data. In this study, it is used to find the mean score of the sample in achievement test in biology.

ii) Standard deviation

Standard deviation is used to find the significant interval to know how much the group has been deviated from the mean score. Further, it is also employed in ‘t’ test. In this study, it is used in ‘t’ test.

iii) Test of significance (t-test)

‘t’- test is used to find the significant difference between two groups. In this study it is used to find the significant difference between control group and IBLMG, control group and CLMG students.

iv) Test of significance (F-test)

‘F’ test is used to find the significant difference among more than two groups. In this study it is used to find the significant difference among control group, IBLMG and CLMG in pre-test and post-test scores.

vi) Correlation techniques

Pearson's product moment correlation is used to find the relationship between two variables. In this study it is used to find relationship between home environment, metacognitive awareness and attitude towards learning biology among higher secondary students.
vii) Multiple regression analysis

In all correlation researches, the strength of a relationship between two or more variables will have to be established only when the variables are quantified. By calculating a correlation between variables it is determined to what degree and direction are they related. The correlation involving relationship between one dependent variable and multiple independent variables, then it requires a better complex technique other than the simple correlation which is usually termed as multiple regression. Multiple regression is used to assess the relative influence of a number of independent variables indicating a prediction of a dependent variable. Therefore, multiple regression is needed when there is a measure of a predicted variable which has been assessed on a continuous scale and when it is required to find out which of the independent variables predict the output or the dependent variable and how much of influence each one has on prediction.

Multiple correlations are computed inorder to assess the extent of contribution of each of the independent variable to the dependent variable in a correlation. There are various methods of multiple correlations and in the present context, a step-wise regression was selected. So in multiple regression one uses two or more predictors to predict the score on the dependent variable. The multiple regression equation becomes

\[ Y = a + b_1 x_1 + b_2 x_2 + b_3 x_3 + \ldots \ldots b_k x_k \]

The dependent variable for the present study has been ‘Gain score’ and multiple independent variables tested for contributions, were ‘metacognitive awareness’, ‘attitude towards learning biology’, and ‘home environment’. In order to examine the relationship between achievement in biology and metacognitive awareness, attitude towards learning biology and home environment, multiple regression equation was formulated.

The regression equation is \[ Y = a + b_1 x_1 + b_2 x_2 + b_3 x_3 \]
Where

\[ Y = \text{Gain Score} \]
\[ a - \text{A constant} \]
\[ b_1 - \text{Regression co-efficient of metacognitive awareness} \]
\[ x_1 - \text{Score of metacognitive awareness} \]
\[ b_2 - \text{Regression co-efficient of attitude towards learning biology} \]
\[ x_2 - \text{Score of attitude towards learning biology} \]
\[ b_3 - \text{Regression co-efficient of dimensions of home environment} \]
\[ x_3 - \text{Score of dimensions of home environment} \]

3.18 DELIMITATIONS

The investigator has delimited the study with the following

- This investigation is restricted to Municipal Girls Hr. Sec. School, Tirunelveli town.
- This investigation is confined to standard XI students.
- Through, there are many psychological factors intervening the achievement of students in this study, the investigator has studied only the following variables.
  - i. Metacognitive awareness
  - ii. Attitude towards learning biology
  - iii. Home environment.
3.19 CONCLUSION

In this chapter, the investigator discussed the need and significance of the study, scope of the study, Objectives, Hypotheses, Design of the study, Sample chosen, Construction and validation of tools, Lesson transcripts of experimental groups and control group, Experimentation schedule, Statistical techniques used and Delimitations. In the next chapter the statistical techniques used were dealt with suitable tabular columns and appropriate illustrations.