CHAPTER III
METHODOLOGY

3.1 Introduction
Methodology of the study provides in-depth knowledge about what type of methodology followed by the researcher in a particular study; it gives direction and suggestion for other researchers to adopt apposite methodology. This chapter included sample and sampling technique, tool and techniques adopted, design of the study and data analysis techniques.

3.2 Sample and Sampling Technique
Sample for the present study was students of standard eight (English Medium) from Gudalur Government Higher Secondary School situated in Gudalur Taluk, Nilgiri District, Tamilnadu. According to SSA mission Tamilnadu, Nilgiri District was identified as one of the special focus districts which require special attention with respect to school education. The literacy rate of Nilgiri District was 85.7% which is comparatively higher than Tamilnadu literacy rate 80.3% (Census, 2011). There are four educational blocks in Nilgiri District they are namely Ooty, Coonoor, Kotagiri and Gudalur (Picture_3.1). There are 724 schools in this district according to State Planning Commission, 2011 (table_3.1). For the present study, Gudalur Educational Block was selected. In this block 199 schools which include Government, private aided and private unaided. Out of 199 schools, Gudalur Government Higher Secondary School students of standard eight were selected purposively. The sample comprised of 28 students (7 Girls and 21 Boys). The purposive sampling method was adopted by considering the following requirements and criteria,

3.2.1 Criteria for Selection of School
1. The school which is ready to provide permission for one complete academic year (2011-2012) to develop process skills through experiential learning.
2. Cooperation from the teachers and Head Master to carry out research throughout the year.
3. Well-equipped multimedia theatre facility.
4. Large sized classroom and laboratory facilities so that group wise students can be engaged in Kolb’s experiential learning cycle for doing science experiments.
Table 3.1: Number of Schools in Nilgiri District

<table>
<thead>
<tr>
<th>Educational Block</th>
<th>Govt/Local body</th>
<th>Private Aided</th>
<th>Private Unaided</th>
<th>Others/ KGBV</th>
<th>Total Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Ooty</td>
<td>150</td>
<td>40</td>
<td>50</td>
<td>11</td>
<td>251</td>
</tr>
<tr>
<td>2 Coonoor</td>
<td>68</td>
<td>61</td>
<td>30</td>
<td>13</td>
<td>172</td>
</tr>
<tr>
<td>3 Kotagiri</td>
<td>62</td>
<td>20</td>
<td>16</td>
<td>04</td>
<td>102</td>
</tr>
<tr>
<td>4 Gudalur</td>
<td>136</td>
<td>18</td>
<td>41</td>
<td>04</td>
<td>199</td>
</tr>
<tr>
<td>Total</td>
<td>146</td>
<td>139</td>
<td>137</td>
<td>32</td>
<td>724</td>
</tr>
</tbody>
</table>

Source: Annual work plan and Budget 2010-2011, SSA

3.2.2 Description about School

Gudalur Government Higher Secondary School was established in the year of 1948 which is located in head quarter of Gudalur taluk (Appendix_8.1). The school having enough space with good infrastructure facilities such as large size play ground, separate computer room, multimedia theatre, adequate toilet facilities for boys and girls, adequate drinking water facility, each grade having separate classroom, no multigrade classroom system, and having separate laboratory for Secondary and Higher secondary students. There were one thousand five hundred and twenty students from sixth to twelfth standard studying in Tamil, Malayalam and English medium during the academic year 2011-12. Total numbers of teachers were forty. Out of forty, thirty five teachers were permanent and five teachers were temporary; all the teachers were professionally trained.
3.3 Sources of Data

Data were collected from students, teachers, Head master, parents and siblings of sampled students by using various tools and techniques. Data pertaining to basic science process skills obtained from students. Data related to profile of school obtained from Headmaster. Data with regard to the effectiveness of experiential learning intervention programme were obtained from sampled students, teachers who are teaching different subjects for sampled students, and their parents and siblings.

3.3.1 Tools and Techniques Employed for Data Collection

To collect the data on Science Process Skills the following tools and techniques were employed

1. Situational test for Students
2. Open ended questionnaire for Students
3. Close ended questionnaire for Students
4. Rating Scale for Students
5. Observation Technique by researcher to observe student behaviour
6. Semi Structured Interview with Students, Parents and Siblings
7. Focussed Group Discussion (FGD) with Teachers
8. Video graphy and still photography

3.4 Tools Construction

From the above mentioned tools and techniques, following tools such as open ended questionnaire, close ended questionnaire, rating scale were constructed by researcher. The descriptions of construction of tools are presented below.

3.4.1 Open Ended Questionnaire for Students

In order to collect the data on science process skills from the selected sample, researcher constructed open ended questionnaire for the students of standard eight. Separate questionnaire was constructed for each process skills such as observation, classification, communication, measurement, prediction and inference. By considering the study objectives, research questions, nature of date required, and students cognitive level, researcher followed the steps of
questionnaire construction given by Mouly (1979). In first step: in order to conceptualise in-depth knowledge about process skills and assessment procedure of process skills, researcher gone through the books, related literature, journals and articles. Then the indicators of each process skills were identified and listed out for questionnaire construction. In second step: further interacted and discussed with experts and scholars to make the questionnaire more effective and to collect the complete data on process skills. In third step: researcher delimited only to basic science process skills indicators for getting valid data on those skills. In fourth step: A rough draft questionnaire was prepared for each basic process skill such as observation, classification, communication, measurement, prediction and inference. The items in the questionnaire consist of all the indicators of basic science process skills. Most of the items in the questionnaire were chosen from sixth, seventh and eighth standard Science textbook of Tamilnadu, few items selected from other text book like UNESCO source book for science and NCERT book. Hence contents of the text book used as medium to assess basic science process skills. The questionnaire was strengthened and ensured that all the items accomplish the objectives of the study. In fifth step: developed tool was sent to the subject experts for validation to ensure the content validity, process validity, and appropriateness of items (Appendix_6.1: List of names of experts). The tool was validated by experts, suggestions and comments were incorporated. In sixth step: The constructed and validated questionnaire consists of 115 items and it was piloted in the students of standard eight. The description of pilot study is as follows.

3.4.2 Piloting of Open Ended Questionnaire
Pilot study was conducted among the students of standard eight in St Thomas Higher Secondary School Gudalur, The Nilgiris following English Medium State Board syllabus (Plate_3.1). According to Johnson and Christensen (2008) researcher should conduct pilot test minimum of five to ten pupil. Accordingly, eight students were selected from standard VIII. Those eight Students have been selected based on their previous year academic performance. The selected students heterogeneous in nature i.e. slow learners, average and gifted students.
While piloting the tool there were 115 items in the questionnaire. Subsequent to completion of pilot test researcher used “Think aloud Technique” to know strength and weakness of the questionnaire. In this technique the participants verbalise their suggestions and perceptions about each items. Think aloud technique is for determining whether participants are interpreting the items the way researcher is intended (Johnson and Christensen, 2008). Based on the participants’ opinions and responses some of the items were deleted, few items were substituted, finally total number of items reduced from 115 to 100 (table_3.2).

**Table_3.2**

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Basic Science Process Skills</th>
<th>No. of Items during Pilot study</th>
<th>No. of Items deleted after Pilot Study</th>
<th>No. of Items Added after pilot Study</th>
<th>Total No. of Items for actual Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Observation</td>
<td>20</td>
<td>08</td>
<td>04</td>
<td>16</td>
</tr>
<tr>
<td>2.</td>
<td>Classification</td>
<td>20</td>
<td>02</td>
<td>-</td>
<td>18</td>
</tr>
<tr>
<td>3.</td>
<td>Communication</td>
<td>17</td>
<td>04</td>
<td>03</td>
<td>16</td>
</tr>
<tr>
<td>4.</td>
<td>Measurement</td>
<td>20</td>
<td>02</td>
<td>-</td>
<td>18</td>
</tr>
<tr>
<td>5.</td>
<td>Prediction</td>
<td>18</td>
<td>02</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>6.</td>
<td>Inference</td>
<td>20</td>
<td>04</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td><strong>115</strong></td>
<td><strong>22</strong></td>
<td><strong>07</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
3.4.3 Finalised Open Ended Questionnaire

In the final form of questionnaire there were 100 items. Utmost care has been taken to cover items from both physical sciences and biological sciences. Most of the items in the questionnaire were performance based wherein students need to perform the experiments and then they wrote responses. Some of the items were activity based wherein students observed the picture and demonstration then they responded.

3.4.4 Principles followed while Constructing Open Ended Questionnaire

- The researcher be broad while framing the questions and did not miss any important skill that the research participant feel relevant.
- Prior to construct the questionnaire researcher carefully reviewed the existing research literature, as well as all related instruments that have already been used by other researchers on process skills.
- The researcher considered students’ age level and their cognitive development.
- Language used in the questionnaire was simple and understandable by the students i.e. Jargon or technical terms were avoided.
- Double barrelled questions were avoided.
- Researcher followed ordering of items in the questionnaire. Positive and easy items are kept first so that students get motivated to answer.

3.4.5 Construction of Close Ended Questionnaire for Students

Close ended questionnaire was constructed by researcher for sampled students to know their achievement on basic science process skills. Researcher has followed steps of questionnaire construction given by Mouly (1979). Constructed questionnaire consist of 35 multiple choice items which covers all basic science process skills such as observation classification communication measurement prediction and inference (Appendix_3.1). The self constructed questionnaire was validated by experts (Appendix_6.1). Experts Suggestions and comments were incorporated.
3.4.6 Construction of Rating Scale for Students

Four point rating scale (Always, Sometimes, Rarely, Never) was constructed by the researcher for the selected sample to know the status of basic science process skills. There are sixty items which includes observation, classification, communication, measurement, prediction and inference skills (Appendix_4.1). The self constructed rating scale was validated by experts (Appendix_6.1).

3.5 Design of the Study

Present study design was developmental cum experimental. Developmental refers that researcher developed basic science process skills among the students in one academic year through experiential learning intervention programme; experimental refers that to what extent implemented programme was effective in terms acquisition of basic science process skills. Design of the present study consists of three phases which are described below

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I</td>
<td>Study the existing status of BSPS before Implementation of Intervention Programme</td>
</tr>
<tr>
<td>Phase II</td>
<td>Development and Implementation of Intervention Programme</td>
</tr>
<tr>
<td>Phase III</td>
<td>Assess the BSPS after implementation of Intervention Programme</td>
</tr>
</tbody>
</table>

3.5.1 Phase I: Study the Existing Status of BSPS before Implementation of Intervention Programme

In this phase, in order to know the existing status of Basic Science process skills, self constructed tools and techniques are administered to the sampled students. The description of administration of tools and techniques are as follows.

3.5.1.1 Administration of Situational Test for Students

Situational test was administered for the students of standard eight. Students were divided into groups, in each group 4 to 5 students. Students had been provided earthworms and shoe flower with hand lens for observation and communication skills. Students’ observed the earthworm and shoe flower. Similarly, to know the status of measurement skill, umbrella and spring balance had been provided to measure the weight (Plate_3.2).
3.5.1.2 Administration of Open Ended Questionnaire for Students

Self constructed open ended questionnaire was administered to find out the existing status of process skills. Clear verbal instruction has been given in detail about each item prior to write responses. The detail description of administration of each questionnaire is described below:

Observation Skill: There are 16 items in this questionnaire (Appendix_1.1). For item numbers 1, 4, 12 and 14, pictures are shown in the questionnaire, students observed them then they responded. For Item number 2, a glass of water with pencil and a coin kept in it for observation. Item number 3, lighted candle kept for observation. Item number 5, real specimens (Ginger and potato) provided for observation. Item number 6, decayed bread and magnifying lens provided for observation (Plate_3.3 (a)). Item number 7, thermometer was kept in a beaker containing water to observe the mercury level in the thermometer.
For item no 8, preserved specimen (centipede) provided to observe. Item numbers 9, chemicals were placed on the table (Plate_3.3 (b)). Item number 10, audio on Saturn planet was played in the computer for listening, after completion of audio, questions were written on the blackboard to know what they have listened. Item number 11, Human blood slide was kept on the microscope, students observed the slide, they responded Plate_3.3 (c). For Item number 13, sand was kept for observation. Item number 15, preserved specimens (Spider) with magnifying lens was kept on the table. Item number 16, real a plant specimen was provided for observation. Students observed the specimens, chemicals, sand and real specimens’ one after another. No time restriction for the students to observe the specimens, slides, chemicals etc. They have taken their own time to observe.

**Classification Skill:** there are 18 items in this questionnaire (Appendix_1.2). For item numbers 3, 10, 12, 14, 16, Pictures are shown in the questionnaire, students classified the things, objects, organisms as per the instruction given in the questionnaire. For Item numbers 7 and 8, plants and animals pictures were shown in the computer to classify them based on the similarities and differences. For item number 11, soluble, insoluble and slightly soluble substances were shown to them for classification. Item number 15, acid and base substances were shown. The item numbers 1, 2, 4, 5, 6, 9, 13, 17 and 18, things, substances, elements and solutions which are listed in the questionnaire, students were classified them into different groups based on the common attributes or characteristics.
**Communication Skill:** There are 16 items in this questionnaire (Appendix_1.3). For Item numbers 1, 6, and 7, graph sheet had been provided to plot the graph for the given data. For item number 10, Human heart diagram chart was hanged on the wall, students drew the same. For item number 12, Human brain model was displayed to draw and label it. Remaining Item numbers 2, 3, 4, 5, 8, 9, 11, 13, 14, 15 and 16, were to write symbols, equation, draw flowchart, pie chart, and bar diagram, to draw tables etc as per the instruction given in the questionnaire. Clear instruction was given to them about each item before responding to the items, however Students raised few questions and the same was clarified by the researcher.

**Measurement Skill:** There are 18 items (Appendix_1.4) in this questionnaire to quantify or measure the objects or liquid using appropriate measuring devices. Questionnaire was distributed to all students, and clear verbal instruction had been given in detail. First, students attempted the following items 1, 2, 4, 5 and 15 because these are the items to measure the length, breadth and height, angle of the diagram shown in the questionnaire, after completion of the above items they were engaged to attempt rest of the items numbers 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, and 18. Item number 3, to measure the volume of water measuring cylinder with water and separate beaker were provided to them. Each student called one after another for measurement, as soon as they completed researcher immediately noted in their questionnaire about the volume of water they measured. Item number 6, to measure the total area of irregular leaf, researcher has given a leaf and graph sheet to the students, the same leaf was circulated to all students to draw outline of leaf on the graph (*Plate_3.4 (a)*). Then they measured the total area of leaf. Item no 7, students measured the weight of a bag with books by using pointer balance. Item no 8, a glass with hot water and cold water provided separately to measure the temperature of water by using thermometer.
Item no 9, desk was placed in the classroom students measured the length, breadth and height by using measurement device (tape) (*Plate_3.4 (b)*). Item no 10, to determine the volume of irregular object (stone), one litre graduated beaker with water and a stone tied with thread were placed on the bench, students measured the volume of stone. Item no 11, simple pendulum experimental set up with scale was placed on the table, students measured the length of the pendulum. Item no 12, cloth and measurement tape was provided to them to measure the length and width of the same. Item no 13, a burette with potassium permanganate solution (KMnO₄) was kept in a stand, students were asked to take exact 15 ml of KMnO₄ solution in a beaker (*Plate_3.4 (c)*, thereafter researcher immediately noted down in their questionnaire about the amount of KMnO₄ solution they measured. Item no 14, students were engaged to measure exact 20 ml of water using pipette tube, after measurement researcher noted down in their questionnaire about how much water they have taken exactly. For item no 16, students measured the classroom temperature by using Fahrenheit and Celsius thermometer. For question no 17, thread had been given to measure the curved line diagram shown in the questionnaire. Item no 18, post card was given to everyone to measure the length and width of the same.
Prediction Skill: There are 16 items in this skill (Appendix No.1.5). Items are based on students’ daily life experiences and observations. Before responding the questions, clear instruction was given about each item. First, students predicted for the following Item numbers 1, 3, 4, 6, 10, 11, 12, 13, 14 and 16 because these are the items can be predicted based on previous experiences. Rest of the items numbers 2, 5, 7, 8, 9, 15 students observed the experiments then they predicted. For item no 2, simple pendulum experiment was performed by the researcher (Plate_3.5(a) then the students predicted for item no 2 (a), (b) and (c). Item no 5, researcher had shown two joined plane mirrors at different angles to predict the angle between two mirrors. Item no 7, cold water and warm water were given separately in two beakers to touch and predict the temperature. Item no 9, different liquids such as coconut oil, kerosene, petrol, honey and water had shown to them to predict miscibility and immiscibility of liquids. Item no 15, Students observed the clouds, moisture and climate outside the class for few minutes, also they recalled the past two days weather report. Based on the observations of climate outside and past two days experiences students predicted that the same day evening going to be rain or not.
Inference Skill: There are 16 items in this skill (Appendix_1.6). First, students’ wrote inference(s) for the following item numbers 2, 6, 7, 14 and 15 because inferences can be derived based on the observations of pictures shown in the questionnaire. The item numbers 1, 3, 4, 5, 8, 9, 10, 11, 12, and 13, students derived inference(s) after observing the experiments. Item no 1, students were observed the experiment kept for observation, then they derived inference(s). Item no 3, soluble and insoluble substances (Wood powder, dust, iron powder, sand and common salt) experiment was performed Plate_3.6 (a) then they derived inference(s). Item no 4, acid base test was shown based on the observations of colour change, students’ derived inference (s). Item no 5, student demonstrated experiment on conduction on heat in solids (Plate_3.6 (b)) then they derived inference(s). Item no 8, student demonstrated the experiment on floatation of following liquids such as Kerosene, castor oil, diesel, honey in water, then they derived inference(s). For Item no 9, researcher demonstrated the experiment on absorption of heat by water, based on the observations of experiment students’ derived inference (s). Item no 10, simple pendulum experiment was demonstrated by researcher, based on the observation students’ derived inference(s). For Item no 11, students performed the activity, and then they derived inference(s) based on observation. Item no 12, researcher demonstrated an experiment on neutralisation of bases by adding acids and derived inference(s). Item number 13, experiment on change of states of matter was demonstrated in front of students for observation, based on observation students derived inference(s). Item no 16, video on different types of levers was shown on the computer for making inference(s).
3.5.1.3 Administration of Close Ended Questionnaire for Students
To know students achievement on basic science process skills, self constructed close ended questionnaire was administered to the students of standard eight. There were thirty five multiple choice items with four options (Appendix_3.1), Students put tick mark for one correct response. Thirty minutes time duration has been given for completing the questionnaire.

3.5.1.4 Administration of Rating Scale for Students
Self constructed four Points rating scale (Always, Sometimes, Rarely, Never) was administered to the students of Standard eight. There are sixty items, to complete the entire items in the rating scale Ninety minutes time duration was given.

3.5.1.5 Semi Structured Interview with Students
Semi structured interview was conducted with the students of standard eight. The main focus of interview was to know whether they employed process skills in earlier class, and status of science teaching in the previous standard. Interview was conducted in one hour, semi structured questions were posed during group interview and further probed (Appendix_5.1).

3.5.1.6 Participant Observation by the Researcher
As a participant, researcher observed behaviour of students during administration of questionnaire and the same was noted down in the field notes.

3.5.1.7 Photography and Videography
During administration of questionnaire still photography and videography was used to record their performance and behaviour.
To administer the tools and techniques, twenty School working days (everyday 90 minutes) were used. During the period of administration of tools and techniques science subject was not taught to the students by the regular teacher or researcher.

3.5.2 Phase II : Development and Implementation of Intervention Programme
In this phase, the intervention programme was developed based on Kolb’s experiential learning cycle and implemented in students of standard VIII to develop basic science process skills. The development and implementation of intervention programme described below.
3.5.2.1 Development of Intervention Programme

- It is no doubt that Science can be best learned through laboratory experiments. Procedural way of knowing science is more concrete and meaningful than the declarative knowledge. Simple hands-on experiments and activities are more important to employ the process skills. Students need to engage in various learning experiences in appropriate learning environment so that they observe, record, analyse, communicate, measure predict and infer etc. Teaching of science should engage in hands-on experience and activities, simulated models, field visit, ICT based learning, model making, projects, group discussion, demonstration, role play, laboratory visit etc. Experiential mode of learning provides such type of learning experiences to the students to acquire knowledge and process skills. Research findings also revealed that constructive approach demonstration, environmental approach, activity based method developed science process skills (Ramkumar, 2003; Amin, 2011; Bhaskar, 2010). NCF (2006) position paper on Science teaching also recommended the experiential mode of learning. By keeping all these view in mind, researcher developed an intervention programme based on Kolb’s experiential learning cycle.

- Prior to develop an intervention programme, researcher analysed the contents of Tamilnadu State science textbook of standard eighth, all the activities and experiments related to the contents were included in the intervention programme; in addition to that, some of the experiments and activities taken from other science source books for example UNESCO resource book for science by considering the following aspects such as age and cognitive maturity of students of standard eight, relevant contents, simple experiments which cover most of the basic science process skills. Hence, the science contents were the medium for developing process skills.

- The selected experiments and activities were listed under different learning experiences such as Hands on Experience, demonstration, role play, field visit, simulation, and multimedia presentation (virtual class) which follows Kolb’s Experiential Learning Cycle.

- Developed programme was sent it for validation and it was validated by the experts (Appendix_6). After validation, the programme was finalised to implement in the academic year of 2011-2012. Meanwhile in the same
academic year (2011) Tamilnadu State School Education introduced new revised Science Curriculum entitled on “Common Curriculum” (Samacheer kalvi). According to new syllabus (Common Curriculum), changes were made in the intervention programme in terms of incorporation of some concepts, experiments/activities. Then the revised intervention programme was implemented in the academic year 2011-12, the detail description of implementation of programme is as follows.

### 3.5.2.2 Implementation of Intervention Programme

- The programme was started to implement in the month of August 2011 and it continued till February 2012. During the period of implementation of Intervention Programme regular science teacher not engaged in teaching science and other activities such as science note correction, book correction, and examination supervision for the sampled students, the entire science syllabus was taught by researcher.

- Before implementing the programme researcher discussed with science teacher and other subject teachers who are regularly teaching to the sampled students to know each student’s academic performances in science. Based on the teachers’ opinion, students had been divided into six groups. Each group consist of five students but in one group there were three students. However the number of groups and number of group members was slightly varied depending upon the experiments and activities. Each group was heterogeneous in nature wherein slow learners and gifted students were placed so that everyone can be participated actively.

- During the period of implementation of intervention programme, the group was framed twice and the group members were reshuffled to develop the socialisation among the students and between the students. The programme was implemented in every day two science periods between 11: 30 am to 1:10 pm (except Every Wednesday). In addition to usual science period, researcher used other periods in case of absence of concern subject teacher.

- Intervention Programme includes hands on experience, simulation, role play, demonstration, multimedia presentation (virtual class experience) and field visit which follows Kolb’s Experiential Learning Cycle.
During Hands on Experience: Group wise students made to sit separately to do experiments in the classroom as well as in the laboratory. Required apparatus were provided and clear instruction given to them with regard to name of the experiment, objectives, procedure, and process skills to be developed. As per the instruction each group engaged in doing different experiments; after completion of given experiment by all the groups, they were shifted to do other experiment, likewise group rotation was done till completion of all the experiments by all the groups.

While doing experiments students started with any one of the stages of Kolb’s Experiential Learning Cycle and followed other stages. Most of the experiments students started from first stage of the cycle called Concrete experiences (CE) and they followed others stages such as Reflective Observation (RO), Abstract Conceptualisation (AC) and Active Experimentation (AE). For some experiments Students begins with Active Experimentation (AE) stage and followed all other stages of cycle. During experimentation, in each stage of the Kolb’s cycle students acquired the basic science process skills. Utmost care has been taken to focus all the groups for enhancing process skills.

In Multimedia Presentation (Virtual Class Experience): Certain Videos on were shown to the students in multimedia theatre with sound effects for acquiring the process skills and concepts. For example different types of glands and hormones in human body; different types of human cells and CRT tubes etc are the videos were shown in multimedia theatre.

In demonstration: Researcher has demonstrated the experiments which are little hazard to the students (e.g heating of chemical substances), and the same experiments were performed by students.

In simulation: group wise students prepared some of the simulated models, for example, cell and its organelles, types of irrigation and the same was presented in front of students. Videos of the same models were also shown through multimedia presentation.

In role play: Students performed different role. For example, they played a as the role of element, and compounds, chemical formula, and valency of a particular chemical compound.
In field visit: Researcher taken the students to the field for observation, first they visited natural biodiversity garden called “Gene Pool”. In this garden, medicinal plant, aquatic plants, xerophytic plants were observed; also they observed preserved animals such as snakes, lizards; insects etc were displayed in museum. Similarly, students were taken to field “vermiculture form” (Earth Worm Culture). This is the seasonal culture in which earthworm was cultured in separate culture medium.

In the above learning experiences, students followed each stage of Kolb’s Experiential Learning cyclic. In each stage of the Kolb’s cycle, students process skills was acquired.

3.5.3 Phase III: Assess the BSPS after Implementation of Intervention Programme

After implementation of intervention programme, students’ basic science process skills status was assessed with the help of following tools and techniques.

1. Open ended questionnaire for students
2. Closed ended questionnaire for students
3. Rating scale for students
4. Observations technique by researcher to observe Students behaviour
5. Photography and Video recording
6. Semi Structured Interview with sample and non sample
7. Semi structured interview with Parents and Siblings
8. Focus Group Discussion with Teachers (FGD)

Of the above tools and techniques, administration of open ended questionnaire, close ended questionnaire, rating scale were already described in phase I (pre intervention programme). Remaining techniques such as semi structured interview with sample, semi structured interview with non sample, semi structured interview with siblings and parents, Focus Group Discussion with Teachers, and participant observation are described below in detail.

3.5.3.1 Semi Structured Interview with Students (Sample)

Semi structured interview was conducted with students of Standard eight to know acquisition of basic science process skills through intervention programme. The interview was conducted an hour, semi structured questions were asked and further probed (Appendix_5.2) to elicit their attitudes, opinions and feelings about intervention programme. The entire interview was recorded and photographed.
3.5.3.2  **Semi Structured Interview with Students (non Sample)**

Semi structured interview was conducted with students of standard eight Tamil medium who were not participated in the study but studying in the same school. The main focus of group interview was to know their knowledge about basic science process skills because these students interacted with present study sample and discussed about various learning experiences and process skills. There were fifty students in the class at the time interview. Semi structured questions were asked and further probed (Appendix_5.3). Interview went on forty five minutes, and the responses were video graphed (Plate_3.7).

**Plate_3.7: Semi Structured Interview with Students (non Sampled)**

3.5.3.3  **Focussed Group Discussion with Teachers**

Focussed group discussion (FGD) was conducted with teachers who are taking different subjects to the students of standard eight. The purpose of FGD was to know teachers opinion on intervention programme and students process skills acquisition because researcher implemented the intervention programme in one academic year, present study students (sample) discussed with teachers with regard to intervention programme and process skills acquisition. To know teachers opinion, FGD was conducted. There were twelve teachers and all students of standard eight (Sample) participated in FGD. Discussion was continued forty five minutes; teachers shared their ideas, experiences, opinions and suggestion about intervention programme and the same was recorded (Plate_3.8).
3.5.3.4 Semi Structured Interview with Parents and Siblings
Semi structured interview was conducted with parents of and siblings of sampled students (Standard eight) to know the opinion on intervention programme. During the period of implementation of intervention programme, students shared their learning experiences with parents and siblings. Thus, researcher visited to parents’ of sampled student’s home for conducting face to face interview. Out of twenty eight parents, eighteen parents were interviewed based on readiness and availability. Some of the students’ siblings who are studying in the same school also interviewed along with parents. The interview was conducted thirty to forty minutes with each parent wherein semi structured questions was posed and further probed (Appendix_5.4). The whole interview was photographed and video graphed.

3.5.3.5 Participant Observations by the Researcher
The entire data collection process, i.e. (i) before implementation of intervention programme (ii) during implementation of intervention programme (iii) after intervention programme. Researcher observed students behaviour and it was noted down in the field notes.

3.5.3.6 Photograph and Video record
Photograph and video record was used during the entire process of data collection (Before, during and after the intervention programme).
During the period of data collection, researcher had been there in the school every day by 9:30 am to till evening 4.00 pm, and engaged in some of the school regular activities such as examination supervision; during programme implementation botany subject was taught for eleventh standard and some chapters in science for tenth standard students.
3.6 Data Analysis
For the present study, data were collected by both quantitatively and qualitatively. Quantitative data were collected through close ended questionnaire and rating scale. Whereas qualitative data were collected through open ended questionnaire, situational test, observation, FGD, semi-structured interview responses. Thus researcher employed mixed method of data analysis. According to Johnson and Christensen (2008) if the data includes both qualitative and quantitative which are normally termed as “multidata”, and these data first classified, and analysed concurrently or sequentially. Accordingly researcher classified qualitative and quantitative data and analysed sequentially.
Quantitative data obtained through closed ended questionnaire, and it was analysed by paired t-test (single group), similarly data collected through rating scale was analysed by chi square (2x4 contingency). The data collected through situational test, observational techniques, interview and focus group discussion (FGD) were analysed qualitatively by following qualitative data analysis techniques such as content analysis, data reduction, data display, and transcription of data.
The data collected through open ended questionnaire was analysed by analytic rubric developed by researcher. According to Yager (2008) Rubric can be holistic, generalised, and analytic. Holistic rubric is for assessing the entire task as a single entity or construct. Generalised rubric is to consider the dimensions of a task as single entity. Analytical rubric is for identification of individual knowledge and skills features critical to and inherent in a task to assess concept understanding, process skills, and habits of mind as separate components. For the present study, researcher developed analytic rubric for each basic process skill such as observation, classification, communication, measurement, prediction and inference to assess individual student performance in each skill (Appendix_2.1 to 2.6). Analytic rubric is useful to provide information about each student’s level of performance in each skill. The following steps were involved while designing and developing the analytic rubrics.

1. Identification of Parameters to be Assessed: first, parameters in each process skill to be assessed was identified from open ended questionnaire, and all the parameters are listed in the left hand side of each rubric (for example: in
observation skill: observing the similarities and differences between plant cell and animal cell is a parameter. Similarly in classification skill: classification of things and objects into conductors and insulators is a parameter. Likewise all the parameters of each skill listed in each rubric).

2. Setting the performance level: Secondly, levels of performance were set in the rubrics. The number of rating levels depending upon the purpose and context of assessment, typically rubrics has three to six rating levels (Stevens and Kenneth, 2007). In these analytic rubrics, four rating levels were used namely beginning stage, developing stage, accomplished stage, and proficient stage. The rating level starts from least performance to most performance, or poor performance to excellent performance, no marks or scores given for any of the rating levels.

3. Description of levels of ratings: The levels of performance in the rubrics categorised into four ratings (Beginning Stage, Developing Stage, Accomplished Stage, and Proficient Stage) which are presented in ascending order i.e. starts from the lowest levels of performance to the highest levels of performance of skill exhibited by a student. Description is given under each levels of performance corresponding to the parameters of each skill. Each description is differs from one level to another, Students’ poor performance description in Beginning stage, somewhat good performance description in Developing Stage, good performance presented in Accomplished Stage, and excellent performance description in Proficient Stage. Based on the above three steps, the rubrics was developed and used it for analysis of open ended questionnaire. The procedure of rubric analysis is presented below.

The collected data with the help of open ended questionnaire was analysed both item wise and skill wise. First, item wise students responses provided in the open ended questionnaire were analysed with the help of rubric (For e.g. percentage of students in Beginning stage, Developing stage, Accomplished stage, and Proficient stage in each item under each skill). Secondly, students overall percentage was calculated in each skill (For e.g. percentage of students in
Beginning stage, Developing stage, Accomplished stage, and Proficient stage in each skill).

Data collected through semi structured interview with students and parents, focussed group discussion (FGD) were analysed by triangulation of data.

Table 3.3: Tools and Data Analysis Techniques

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Tools and Techniques Used for Data Collection</th>
<th>Analysis Techniques Employed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective No. 1 To find out the status of Basic Science Process Skills.</td>
<td>Situational test</td>
<td>Content analysis</td>
</tr>
<tr>
<td></td>
<td>Open ended questionnaire</td>
<td>Analysed by Rubrics</td>
</tr>
<tr>
<td></td>
<td>Closed ended questionnaire</td>
<td>Paired t test</td>
</tr>
<tr>
<td></td>
<td>Rating scale</td>
<td>Chi Square (2x4 Contingency)</td>
</tr>
<tr>
<td></td>
<td>Participant Observation (Field notes and Video recording).</td>
<td>Content Analysis</td>
</tr>
<tr>
<td>Objective No. 1&amp;2 Development and Implementation of Intervention Programme.</td>
<td>Participant Observation</td>
<td>Qualitative analysis</td>
</tr>
<tr>
<td>Objective No. 4: To assess the acquisition of process skills after Intervention Programme.</td>
<td>Open ended questionnaire</td>
<td>Analysed by Rubrics</td>
</tr>
<tr>
<td></td>
<td>Closed ended questionnaire</td>
<td>Paired t test</td>
</tr>
<tr>
<td></td>
<td>Rating Scale</td>
<td>Chi Square (2x4 Contingency)</td>
</tr>
<tr>
<td></td>
<td>Participant Observation</td>
<td>Content Analysis</td>
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<tr>
<td></td>
<td>Interview with students</td>
<td>Triangulation of data</td>
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<tr>
<td></td>
<td>Focus Group Discussion</td>
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<tr>
<td></td>
<td>Interview with parents</td>
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</tr>
</tbody>
</table>

This chapter described about the methodology adopted for the present study. The subsequent chapter describe the analysis and interpretation of data.