CHAPTER - III  
DESIGN OF STUDY

3.0 Introduction:

The design of the study is the basic conceptual structure within which the research is conducted. It is basically the plan of action or a blueprint for population, selection of sample, tools used, collection and analysis of data. Thus the present chapter deals with the above mentioned aspects under the following heads;

(i) Population

(ii) Sample

(iii) Tools Used

(iv) Data Collection

(v) Statistical techniques used

3.1 Population:

The population of study is comprised of X class students of the schools affiliated to MBOSE situated in the East Khasi Hills District of Meghalaya. The District of East Khasi Hills has total of 202 secondary schools under MBOSE and the total enrolment in class X is approximately 5651 in year 2009. The details of the population are given below in Table No. 3.1.
Table No. 3.1
Types of Secondary Schools with Total Number of Students in class X

<table>
<thead>
<tr>
<th>SL. No.</th>
<th>Types of school</th>
<th>No. of Schools</th>
<th>Total No. of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Government</td>
<td>02</td>
<td>40</td>
</tr>
<tr>
<td>2.</td>
<td>Deficit</td>
<td>23</td>
<td>937</td>
</tr>
<tr>
<td>3.</td>
<td>Adhoc</td>
<td>87</td>
<td>2291</td>
</tr>
<tr>
<td>4.</td>
<td>Unaided</td>
<td>21</td>
<td>931</td>
</tr>
<tr>
<td>5.</td>
<td>Newly Permitted</td>
<td>69</td>
<td>1452</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>202</strong></td>
<td><strong>5651</strong></td>
</tr>
</tbody>
</table>

Source: Office of the Inspector of Schools, East Khasi Hills District, Shillong, 2009

3.2 Sample:

The sample for the present study is consisted of 553 students from 22 schools studying in class X, which were selected randomly by giving fair representation to all type of schools. The details of the sample are given below in Table No. 3.2.

Table No. 3.2
Number of Students Selected for Sample

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Type of schools</th>
<th>No. of schools</th>
<th>No. of students for sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Government</td>
<td>01</td>
<td>11</td>
</tr>
<tr>
<td>2.</td>
<td>Deficit</td>
<td>02</td>
<td>48</td>
</tr>
<tr>
<td>3.</td>
<td>Adhoc</td>
<td>09</td>
<td>222</td>
</tr>
<tr>
<td>4.</td>
<td>Unaided</td>
<td>02</td>
<td>134</td>
</tr>
<tr>
<td>5.</td>
<td>Newly Permitted</td>
<td>08</td>
<td>138</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>22</strong></td>
<td><strong>553</strong></td>
</tr>
</tbody>
</table>
3.3 Tools Used:

In order to obtain the required data the following tools were used in the present study;

(a) Scientific Attitude Scale constructed by Dr. S. C. Gakhar and Dr. Amandeep Kaur\(^1\).

(b) Scientific Aptitude Test Battery constructed by Dr. K.K. Agarwal, and Dr. Saroj Aurora\(^2\).

(i) **Scientific Attitude Scale**:

The SAS used in the present study has been entrusted by Dr S. C. Gakhar and Dr. Amandeep Kaur. The same has been described in brief as given below;

(a) **Description of the Test**

The test is meant for measuring the scientific attitude of secondary school students. It consists of following nine sub parts with total of 61 items.

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1 Dr. S.C. Gakhar and Dr Amandeep Kaur, “Scientific Attitude Scale” (SAS), Rakhi Prakashan, Agra, India, 1985.
2 Dr. K K Agarwal and Dr. Saroj Aurora, “Scientific Aptitude Test Battery” (SATB), National Psychological Corporation, Agra, India, 1971.
Table No. 3.3
Description of Scientific Attitude Scale

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Sub – Tests</th>
<th>Name of the Components/Dimensions</th>
<th>Number of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Part – I</td>
<td>Curiosity</td>
<td>06</td>
</tr>
<tr>
<td>2.</td>
<td>Part – II</td>
<td>Open-Mindedness</td>
<td>10</td>
</tr>
<tr>
<td>4.</td>
<td>Part – IV</td>
<td>Cause and Effect Relationship</td>
<td>05</td>
</tr>
<tr>
<td>5.</td>
<td>Part – V</td>
<td>Critical Mindedness</td>
<td>01</td>
</tr>
<tr>
<td>6.</td>
<td>Part – VI</td>
<td>Seeks Evidence</td>
<td>10</td>
</tr>
<tr>
<td>7.</td>
<td>Part – VII</td>
<td>Objectivity</td>
<td>09</td>
</tr>
<tr>
<td>8.</td>
<td>Part – VIII</td>
<td>Suspended Judgment</td>
<td>02</td>
</tr>
<tr>
<td>9.</td>
<td>Part – IX</td>
<td>Aversion to Superstition</td>
<td>05</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>61</strong></td>
</tr>
</tbody>
</table>

The scale has been constructed on five point scale viz. strongly agree, agree, undecided, disagree and strongly disagree.

(b) Administration of the Test

The test may be administered in a regular class room. Test booklets are consumable. Answers are to be marked on the booklet itself by putting tick (✓) mark in one of the option.
(c) **Reliability**

The Reliability of SAS was tested by test – re-test method. The coefficient of correlation of two test scores is found to be 0.70, which is fairly high.

(d) **Validity of the Test**

The validity of the test was determined by seeking the opinion of four experts in subject matter & three experts in test construction. The experts agreed 92% on the assignment of scale items. This was taken as evidence of content validity.

(e) **Answer Sheet and Scoring Key**

The test provides a consumable booklet having questions with a space for putting tick (✓) mark as their answer. The test can be scored by giving 05 marks for strongly agree, 04 for agree, 03 for undecided, 02 for disagree and 01 for strongly disagree for positive statements. The process of scoring for negative statements is reversed. Negative statements were given scores of 01, 02, 03, 04 and 05 for Strongly Agree, Agree, Un-decided, Disagree and Strongly Disagree respectively as given in Table No.3.4 as under.
Table No. 3.4
Scoring of Items

<table>
<thead>
<tr>
<th>Response</th>
<th>For positive items</th>
<th>For negative items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Agree</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Un-Decided</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Disagree</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

(f) Interpretation

Taking clue from Scientific Attitude scoring on a 05 (five) point scale the following table has been derived for interpretation, by the investigator.

Table No. - 3.5
Interpretation Table

<table>
<thead>
<tr>
<th>Scale Range</th>
<th>Limits of Scores</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5 and above</td>
<td>276 &amp; above</td>
<td>Strongly Favorable (SF)</td>
</tr>
<tr>
<td>3.5 – 4.4</td>
<td>214 - 275</td>
<td>Favorable (F)</td>
</tr>
<tr>
<td>2.5 – 3.4</td>
<td>153 – 213</td>
<td>Neutral (N)</td>
</tr>
<tr>
<td>1.5 - 2.4</td>
<td>92 – 152</td>
<td>Unfavorable (U)</td>
</tr>
<tr>
<td>below 1.5</td>
<td>Below 92</td>
<td>Strongly Unfavorable (SU)</td>
</tr>
</tbody>
</table>
(ii) **Scientific Aptitude Test Battery:-**

(a) **Description of Test**

The Scientific Aptitude Test Battery has been developed to predict the success in science at high school level. The battery of test consists of following four sub-tests.

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Sub-test</th>
<th>Time</th>
<th>Items</th>
<th>Total No of items</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Reasoning Test</td>
<td>25 mts</td>
<td>40</td>
<td>12</td>
</tr>
<tr>
<td>2.</td>
<td>Numerical Ability Test</td>
<td>30 mts</td>
<td>24</td>
<td>28</td>
</tr>
<tr>
<td>3.</td>
<td>Science Information Test</td>
<td>20 mts</td>
<td>24</td>
<td>26</td>
</tr>
<tr>
<td>4.</td>
<td>Science Vocabulary Test</td>
<td>15 mts</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) **Administration of the Test**

The test may be administered in a regular class room. Each sub-test contains practical examples. The directions for taking the test are printed on the test booklet. The total time taken for the test is 90 minutes. Test booklets are re-usuable and answers are to be marked on a separate answer sheet provided along with the test booklet.
(c) **Reliability of the Test**

Two methods have been used by the authors for computing the reliabilities of each sub-test constituting the battery, viz. Test – Retest and Split – half method. Below are given the reliabilities of each sub-test:

**Table No. – 3.7**

**Reliability Testing of SATB**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Type of Test</th>
<th>Test retest</th>
<th>Split-half</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Reasoning Test</td>
<td>.90</td>
<td>.91</td>
</tr>
<tr>
<td>2.</td>
<td>Numerical Ability Test</td>
<td>.91</td>
<td>.91</td>
</tr>
<tr>
<td>3.</td>
<td>Science Information Test</td>
<td>.84</td>
<td>.84</td>
</tr>
<tr>
<td>4.</td>
<td>Science Vocabulary Test</td>
<td>.93</td>
<td>.84</td>
</tr>
<tr>
<td></td>
<td>Entire Battery</td>
<td>.94</td>
<td>.93</td>
</tr>
</tbody>
</table>

(vi) **Validity of the Test**

The battery of the tests has been validated by the authors against high school examination marks in science, mathematics and total. The validity co-efficient being .59, .57 and .58 respectively which are quite satisfactory.

(vii) **Norms & Interpretation**

For interpreting the raw scores three types of norms have been provided for each test. The norms are in percentiles, standard scores and in stanine. The raw scores of each test are converted into weighted scores by multiplying test I (reasoning)
by 1.33, test II (numerical) by 1, test III (science information) by 02 and test IV (science vocabulary) by 03. Final weighted score is calculated by adding the weighted scores of each sub-tests. The manual has classified the scientific aptitude in five grades (viz. high, above average, average, below average and low) on the basis of their weighted scores which has been clubbed in three grades as per the requirement of the present study. The same is given below;

**Table No. 3.8**

**Grading of Scores**

<table>
<thead>
<tr>
<th>Weighted Scores</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>239 – 293</td>
<td>High</td>
</tr>
<tr>
<td>156 – 238</td>
<td>Average</td>
</tr>
<tr>
<td>0 – 155</td>
<td>Low</td>
</tr>
</tbody>
</table>

(viii) **Answer Sheet and Scoring Key**

The test provides a re-usable booklet of question paper containing 20 sheets and an answer sheet of 04 pages. It also provides the manual for the test battery which consist of 15 pages including the scoring key for all the four sub-tests.

3.4 **Method of Study:**

It is the nature of problem under investigation which determines the adoption of particular method of research. For the present study,
Ex Post Facto method of research has been used. The term Ex Post Facto is used to refer to an experiment in which the researcher, rather than creating the treatment, examines the effect of a naturally occurring treatment after it has occurred. In the present study, the effect of two naturally occurring treatment variables viz.: scientific attitude and scientific aptitude on the academic achievement in science subject of class X students is being studied.

3.5 Data Collection Procedure:

For the purpose of data collection the investigator first of all took formal permission from the heads of the institutions in order to administer the test to class X students. After seeking the permission from the principals, the investigator met the subjects in view to establish a rapport with them. The request was rendered to subjects to participate whole-heartedly and sincerely while responding to the test.

In order to make the investigation successful, the adequate efforts were made to impress upon the students that their co-operation in marking appropriate answers to the questions is vital. The students were assured that their responses will be kept strictly confidential and will be used for research purpose only.

Both the tests were administered concurrently on the same day with a provision for break between the tests. While administering the
tests instructions were read-out by the investigator and the illustrative examples were explained to the students and all the doubts were clarified. After the investigator was satisfied that the subjects were fully aware of the correct procedures involved to attempt the tests, they were asked to take the tests. A constant vigil was kept over the class while test administration was made to make sure that everything went smoothly. Two tests viz.: scientific attitude scale and scientific aptitude test battery were then administered one by one. The entire administration took about 03 hours per school to complete.

The performance of the students in science subject in Higher Secondary School leaving certificate examination conducted by Meghalaya Board of School Education was taken as the data for academic achievement in science subject. The marks obtained by the subjects in the sample were taken from the School records/mark sheets.

3.6 Statistical Techniques Used:

The present study has used the following statistical techniques:\(^3\);

(i) **Mean and Standard Deviation:-**

The following formulae for calculating Mean and Standard Deviation were used:

a) **Mean**

The following formula for calculating Mean is given below:

\[
M = AM + \frac{\sum fx'}{N}X_i
\]

Where,

- \(M\) = Mean.
- \(AM\) = Assumed Mean.
- \(N\) = Number.
- \(\sum\) = The summation.
- \(x'\) = Deviation.
- \(f\) = Frequency.
- \(i\) = Size of class intervals.

b) **Standard Deviation**

The following formula for calculating Standard Deviation is given below:

\[
\sigma = i X \sqrt{\frac{\sum fx'^2}{N} - \left(\frac{\sum fx'}{N}\right)^2}
\]

Where,

- \(\sigma\) = Standard Deviation.
- \(i\) = Size of the class intervals.
- \(\sum\) = The summation.
- \(f\) = Frequency.
- \(x'\) = Deviation.
- \(N\) = Number.
(ii) Percentage was also used for calculation.

(iii) **Pearson’s Coefficient of Correlation:**

\[
r = \frac{N \sum x' y' - \sum fx' \sum fy'}{\sqrt{[N \sum fx'^2 - (\sum fx')^2][N \sum fy'^2 - (\sum fy')^2]}}
\]

Where:

- \(x'\) = The deviation of variable \(x\) from the assumed mean.
- \(y'\) = The deviation of variable \(y\) from the assumed mean.
- \(f\) = Frequency of the score.
- \(fx'^2\) = The sums of the square \(x\) value.
- \(fy'^2\) = The sums of the square \(y\) value.
- \(N\) = Size of the sample.
- \(\Sigma\) = The summation.

(iv) **Multiple correlation:**

\[
R_{1,23} = \sqrt{r_{12}^2 + r_{13}^2 - 2r_{12} \cdot r_{13} \cdot r_{23}} \div (1 - r_{23}^2)
\]

Where:

- \(r_{12}\) = Correlation between achievement and SAS (Scientific Attitude Scale) scores.
- \(r_{13}\) = Correlation between achievement and SATB (Scientific Aptitude Test Battery) scores.
- \(r_{23}\) = Correlation between SAS and SATB scores.
(v) **Significance of Multiple Correlation:**

To test the significance of multiple correlations, F test has been employed as under and F value has been calculated by the following formula:

\[
F = \frac{\frac{R^2}{N-K-1}}{\frac{1-R^2}{K}}
\]

Where;

- \( R^2 \) = Multiple determination
- \( N \) = Size of the sample
- \( K \) = Number of variables

To see the table value the following value of df is used.

\[
df_1 = K,
\]

\[
df_2 = (N-K-1)
\]

(v i) **Z - Value:**

The following formula for calculating Z – Value is given below:

\[
\sigma_D = \sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}
\]

\[
Z = \frac{D}{\sigma_D}
\]
Where;
\( \sigma_1, \sigma_2 \) are respective standard deviations of variables taken.

\( N_1 \) and \( N_2 \) are number of frequencies.

\( D \) is \( M_1 - M_2 \)