CHAPTER III

METHODOLOGY

Method Adopted for the Study
Variables of the Study
Tools Used for Measurement
Sample Used for the Study
Collection of Data
Statistical Techniques Employed
CHAPTER III

METHODOLOGY

The hypotheses set for the study suggested the procedure to be adopted for conducting the study. The details of the procedure adopted are briefly described below under the following heads:

3.1 Method adopted for the study
3.2 Variables of the study
3.3 Tools used for measurement
3.4 Sample used for the study
3.5 Collection of data
3.6 Statistical techniques employed

3.1 METHOD ADOPTED FOR THE STUDY

The present study aims at studying the association between Achievement in Science and certain other variables. So the Normative Survey method was found suitable for the collection of data as it has the following characteristics:

(i) It gathers data from a relatively large number of cases;
(ii) It is cross sectional, mostly for what exists type;
(iii) It is concerned with generalised statistics of the whole population or a sample;
(iv) It involves clearly defined problems and definite objectives.
(v) It provides information useful to the solution of current practical problems.
(vi) It suggests the cause of future development.

3.2 VARIABLES OF THE STUDY

In research works, independent variables are manipulated by researcher and measures changes in dependent variables (Burns, 2000).

In the present study, the dependent variable is Achievement in Science. Independent variables are:

1. Intelligence
2. Scientific Creativity
3. Achievement Motivation
4. Home Environment

3.3 TOOLS USED FOR MEASUREMENT

A number of standardised psychological and educational tests were collected for measuring the different variables. Certain criteria were set up for selecting the tools. They are:

(i) The tool should be standardised for the population in question;
(ii) The tools should yield valid and reliable measures of the variables in question;
(iii) The tool should be in the regional language, which is the medium of instruction in most of the schools in the State;
(iv) The tool should be a group test so that a reasonably large number of pupils can be tested at a time
(v) The tool should be provided with standardised instruction for administration and scoring.

Thus, the following tools were selected for the present study.

2. Kerala University Group Test of Intelligence for Adults
3. Raven’s Progressive Matrices Test
4. Kerala scale of Achievement Motivation, and
5. Home Environment Inventory

The psychometric descriptions and other relevant details of the above tools are presented below.

3.3.1 Measurement of Scientific Creativity

Scientific Creativity test

An apt tool for measuring the Scientific Creativity of Higher Secondary School pupils with due weightage to verbal and figural Scientific Creativity was not available. So, the investigator decided to prepare a Test of Scientific Creativity.

A standardised test has high validity and reliability and it provides norms for various groups. Standardisation is defined by Waren (1934, p.261) as the establishment of fixed or standardised procedure in giving and scoring of tests, as well as the establishment of adequate age, grade, race or other norms.

Therefore, it was decided to construct a standardised test on Scientific Creativity for Higher Secondary School Science students.
The important steps in the construction and standardisation of the test are:

1. Planning the test
2. Preparing the test
3. Trying out the test
4. Evaluating the test

**Planning the Test**

"Good test do not just happen nor are they the result of a few moments of high inspiration and exaltation. On the contrary, the process is calm, deliberate and time consuming." (Ross and Stanley, 1954, p.140).

The investigator went through several books and journals in Science, Psychology, Education, Evaluation and Research Methodology and other such materials to find out details regarding test construction. The investigator also met many experts in the field. The Creativity Test of Guilford and the Minnesota Test of Creativity were referred and selected as the base for the preparation of the present test. Details of the above tests are given below.

**Guilford’s Test of Creativity**

The following factors and tasks summarise Guilford’s theory concerning the measurement of creative thinking abilities (Torrance, 1962, pp. 30-31).
### Table 3.1

**Factors, Tests and Descriptions of Guilford’s Creativity Test**

<table>
<thead>
<tr>
<th>No.</th>
<th>Factor</th>
<th>Tests and Descriptions</th>
</tr>
</thead>
</table>
| 1.  | Sensitivity to problems (seeing defects, needs, deficiencies, seeing the odd, the unusual, seeing what must be done) | • Apparatus Test – Suggest two improvements for a common appliance.  
• Seeing Problems – List problems that might arise in connection with common objects.  
• Seeing Deficiencies – Point out the way in which a described plan or activity is faulty. |
| 2.  | Figural Spontaneous Flexibility                                         | • Cube Fluctuations – Indicate the number of changes in perspective of ambiguous cube (Thurstone)  
• Windmill Alternations – Indicate the number of alternations form the illusion to another while observing shadow of rotating rectangular blade (Thurstone)  
• Retinal-Rivalry Reversals – Indicate the number of reversals when a blue field is presented, stereoscopically to one eye and a yellow field to the other eye (Thurstone) |
| 3.  | Figural Adaptive Flexibility                                           | • Match Problems II – Indicate three or four different patterns of a specific number of matches that can be removed to leave a specified number of triangles and squares.  
• Match Problems III – Indicate several different patterns of matches that can be removed to leave a specific number of squares.  
• Planning Air Manoeuvres – Select the most direct in ‘Sky Writing’ letter combinations (USAF) |
| 4.  | Word Fluency                                                           | • Suffixes W-1 – Write words ending with a specific suffix (ETS)  
• Prefixes W-2 – Write words beginning with a specified prefix (ETS)  
• First and last letters W-3 – Write words beginning and ending with a specified letter (ETS) |
<table>
<thead>
<tr>
<th>No.</th>
<th>Factor</th>
<th>Tests and Descriptions</th>
</tr>
</thead>
</table>
| 5   | Expressional Fluency        | • Expressional Fluency – Write four word sentences when the first letter of each is given  
• Simile Interpretations – Complete sentence that states an analogous idea  
• Word Arrangements – Write sentences containing four specified words |
| 6   | Ideational Fluency          | • Topics IF-1 – Write as many ideas as possible about a given topic (ETS)  
• Theme IF-2 – Write as many words as possible about a given topic (ETS)  
• Thing Categories IF-3 – List the name of 'things that are round or that could be called round'  
• Ideational Fluency – Write names of things fitting into broad classes. |
| 7   | Semantic Spontaneous Flexibility | • Brick Uses – Write a variety of uses for a brick  
• Alternate Uses – List different peculiar uses for common objects |
| 8   | Associational Fluency       | • Controlled Associations – Write as many synonyms as possible for each given word  
• Simile Insertion – Write adjectival completion for a simile.  
• Associations IV – Produce a word that can be associated with two given words  
• Associational Fluency I – Write synonyms for given words |
| 9   | Originality                 | • Plot Titles (Clever) – Write clever title for story plots  
• Symbol Production – Produce symbols to represent activities and objects  
• Consequences (remote) – List remote consequences of certain changes |
| 10  | Semantic Elaboration        | • Planning Elaboration – Fill in as many details as necessary to make a briefly outlined activity work  
• Figure Production – Add to given lines to produce a meaningful figure. Score is based on number of details drawn |
### Test Descriptions

<table>
<thead>
<tr>
<th>No.</th>
<th>Factor</th>
<th>Tests and Descriptions</th>
</tr>
</thead>
</table>
| 11. | Figural Redefinition (Defining or perceiving in a way different from the usual, established or intended way, use, etc.) | - Concealed Figures CF-1 – Indicate which of four complex geometrical figures contains a given geometrical figure (ETS)  
- Penetration of Camouflage – Locate faces hidden in pictures (USAF)  
- Hidden pictures – Find human or animal pictures hidden in a scene, as rapidly as possible (Thurstone)  
- Hidden Figures – Indicate which of the five figures is hidden in a given figure |
| 12. | Symbolic Redefinition                 | - Camouflaged words – Find the name of the sport or game concealed in a sentence  
- Word Transformation – Indicate new divisions between letters in a new series of words forming phrase, to make a new series of words. |
| 13. | Semantic Redefinition                 | - Gestalt Transformation – Indicate which of the five listed objects has a part that will serve a specified purpose  
- Object Synthesis – Name an object that could be made by combining two specified objects  
- Picture Gestalt – Indicate which object in a photograph will serve a specified purpose. |

**The Minnesota Test of Creativity**

The Minnesota Test developed by Torrance and his colleagues (Torrance, 1962) is a widely used one. The test in this battery are described below.
### Table 3.2

**Tasks, Tests and Descriptions of Minnesota Test of Creativity**

<table>
<thead>
<tr>
<th>No.</th>
<th>Tasks</th>
<th>Tests and Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Non Verbal Tasks</td>
<td>• Incomplete Figure Task – Six incomplete figures are given. Add lines and complete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>figures using stimulus figures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Picture Construction Task – Construct a picture that includes the given shape</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Circles and Square Task – Two printed forms with 35 squares in one and 42 circles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>in the other. Sketch figures with circles and squares as the main element</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Creative Design Task – Construct designs using the given circles, strips of colours,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>booklet, scissors and glue.</td>
</tr>
<tr>
<td>2.</td>
<td>Verbal Tasks using Non</td>
<td>• Ask and Guess Test – Ask questions about the given picture which cannot be answered</td>
</tr>
<tr>
<td></td>
<td>Verbal Stimuli</td>
<td>by looking at the picture. Then make guesses about the possible causes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Product improvement Tasks – Four objects (toys) are given. Give suggestions for its</td>
</tr>
<tr>
<td></td>
<td></td>
<td>improvement.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Unusual Uses – Objects are given. List the most unusual uses of it.</td>
</tr>
<tr>
<td>3.</td>
<td>Verbal Tasks using Ver-</td>
<td>• Unusual uses – Give the unusual uses of tin, can or books</td>
</tr>
<tr>
<td></td>
<td>bal Stimuli</td>
<td>• Impossible Task – List as many impossible tasks as they can think of.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Consequences – List the consequences of an improbable theme.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Just Suppose – Subject is confronted with an improbable situation; predict the possible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>outcomes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Situations – Suggestions on what needs to be done in specific situations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Common Problems – Two common situations; give the problems that might arise in</td>
</tr>
<tr>
<td></td>
<td></td>
<td>connection with these situations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Improvements – Suggest two improvements on three appliances</td>
</tr>
</tbody>
</table>
Selection of Tasks to Assess Scientific Creativity

Based on the above tests, the investigator took decisions regarding the components of scientific Creativity to be included in the test. The major components identified by Guilford (fluency, flexibility, originality, elaboration and redefinition and sensitivity to problems) were selected.

Then decisions about the content to be selected, form of items and length of the test were taken. Content of the test is based on the scientific awareness that we expect from a higher secondary school student. It includes concepts of physics, chemistry and biology in verbal and figural forms.

Since the test is aimed to measure the divergent thinking ability, open-ended questions are formed and the respondent can reply in his own words allowing several possible correct responses.

In addition to Scientific Creativity Test, four other tools are to be administered to the same sample to collect data for the present study. Generally, adolescent students are not patient enough to attend longer written tests. It is found that the shorter the tests, the higher the number of subjects
completing the test. Taking these assumptions into consideration, it was decided to construct a test for 90 minutes (including the time for giving instructions) which would serve the purpose of measuring Scientific Creativity of Higher Secondary School pupils.

For higher secondary classes, the medium of instruction is English. So the test was prepared in English. However, the respondents are allowed to answer in the mother tongue (Malayalam) whenever they feel difficulty in answering in English.

Preparing the Test

The test items were prepared based on the following principles:

The items selected should be

- suitable for the cognitive level of the Higher Secondary School Students
- related to the physical and social environment of the learners
- motivating for imaginative insights
- helpful for promoting critical thinking skills
- easily scorable
- presented in unambiguous terms
- accessible to learners with minimum instruction
- simple and of proper length to avoid fatigue and boredom.

Thus, a careful scrutiny of the items with regard to language, length, clarity and accuracy was done with the help of the Supervising Teacher.
The items selected were grouped into five major parts. They are:

- **Part A** – Fluency
- **B** – Flexibility
- **C** – Originality
- **D** – Elaboration and Redefinition
- **E** – Sensitivity to Problem

**Description of the Tasks and Test items**

A brief description of the tasks and test items is given below.

**Part A – Fluency**

*Word Fluency: Prefixes*

This is a direct adaptation of Guilford's Word Fluency: Prefixes W-2. Here, the examinee has to write down as many scientific words as he can which begin with a specified prefix.

An example for the item is given below.

Write as many scientific words as possible beginning with In...

Ans: Induction, Inertia, Incubation, Insulator

*Word Fluency – Suffixes*

This is a direct adaptation of Guilford's Word Fluency Suffixes W-1. The subject has to write as many scientific words as he can which end with the specified suffix. The emphasis here is on fluency (i.e., the sheer number of responses) while the subject who can write unusual words will probably be given score for originality.

An illustration of an item is given below.

Write as many words as possible associated with science ending in ...ance

Ans: Resistance, Inductance, Reactance, Valance
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Ideational Fluency: Topics IF-1 and Topics IF-2

This is mostly on the lines of Guilford's Ideational Fluency: Topics IF-1 and IF-2. The tasks in this test are designed to measure fluency in terms of rate of generation of ideas. Instructions emphasise sheer number of responses produced rather than their quality. Unusual responses will tend to increase with the total number of responses produced.

Example of an item is as follows:
Give maximum number of examples for household chemicals.

Associational Fluency: Associations

This is an adaptation of Guilford's Associational Fluency: Associations IV, in which the subject has to produce a word that could be associated with two given words. Associational fluency as measured by the test pertains to the completion of relationship in distinction with ideational fluency which involves generation of ideas. Associational fluency measures the ability of an individual to associate terms fluently.

An illustration of the items would be:
Write as many compounds as possible by combining the elements Sulphur and Oxygen.

Part B – Flexibility

Semantic Spontaneous Flexibility: Alternate Uses

This is a modification of Guilford's Alternate Uses Test intended to measure semantic spontaneous flexibility. The subject is required to write as many usual and unusual applications of the given concept.
Example for this task is given below.

Write down as many usual and unusual uses of 'Water'

**Figural Adaptive Flexibility: Match Problems**

This is a modified form of Guilford's Figural Adaptive Flexibility: Match Problems. This means changes of some kind – changes in the interpretation of the task, approach or strategy or in possible solution. The examinee must produce the shifts or changes in meaning and so come up with novel, unusual, clever or farfetched ideas. Match problems are based upon the common game forming patterns with match sticks.

The examinee is to form as many chemical symbols as possible using sticks by rearranging or taking away the match sticks of the given symbol.

Figure given  

Ans:  

**Part C – Originality**

**Novelty: Remote Consequences**

It is an adaptation of Guilford's originality. Remote consequences intended to measure a subjects' originality in imagining the consequences of certain unusual situations. Each item starts with a highly improbable universal event, and the subject has to imagine and then write the consequences making as many guesses as he can, of the occurrence of that event. The test is based on free play of imagination and originality.

An illustrative item is given below.
Qn: What would happen if the Sun loses its light?
Ans: No light; No rain; No plants; No solar energy ..........

**Novelty: Picture Completion**

This test has been taken from Torrance’s Minnesota tests. Here, the subject is asked to sketch some designs related to science by making additions to an incomplete figure given and to give suitable title to the new drawing. The sketches are expected to be original and different from one another.

A sample item is given below.

<table>
<thead>
<tr>
<th>Incomplete figure</th>
<th>Completed figures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Novelty: Plot Titles**

This is a modified version of Guilford’s Plot Titles (clever). The subjects are asked to write clever scientific titles for the cartoons.

**Novelty: Imaginative Stories**

This is taken from Torrance’s Minnesota Test of Creativity, Verbal Tasks using Verbal Stimuli: Imaginative Stories. Here, the subject is asked to write imaginative stories on scientific topics given.

Example for the task is given below.

Write an interesting story about Talking Viruses.
**Novelty: Just Suppose**

This is derived from Torrance’s Minnesota Test of Creativity: Just Suppose. The subject is confronted with a problematic situation and they are asked to make suggestions to solve the confusion.

An illustrative item is given below.

You meet a group of people in a remote village who believe that using medicines for diseases is a sin against their God. What would you do to change their attitude?

**Multiplicity: Identification and Illustration**

This task require the subject to identify the objects/items given and make the appropriate illustrations. The items are presented in figural form.

**Multiplicity: Suggestions**

Here, the subjects are asked to assume that they are provided with certain objects. They have to make suggestions about procedures of actions with the available objects. Those giving unusual suggestions would get more scores for Originality.

An example of the task is given below.

What would you do if you get ‘a flower’

**Multiplicity: Multiple Grouping**

This task consists of items to test whether there is ability to produce multiple classes. The subject has to group the items to categories and to write name of the categories also. An example is given below.

Arrange the elements to different groups. Name the group.
Aluminium Calcium Carbon Chlorine Copper Helium

Answer: Gases ➔ Chlorine, Helium
Metals ➔ Aluminium, Copper

Part D – Elaboration and Redefinition

**Figural Redefinition: Concealed Phenomena**

This is a modified form of Guilford’s Figural Redefinition: Concealed Figures CF-1. Redefinition involves the changing of functions or uses of parts of one unit and giving them new functions or uses in some new unit. The subject has to recognise the scientific concept concealed in the given pictures which helps him to redefine the figure scientifically.

**Symbolic Redefinition: Camouflaged Words**

This is a modified version of Guilford’s Symbolic Redefinition: Camouflaged Words. This is a word search puzzle in science. The subject is required to find the scientist in the given puzzle. Thus, his ability to redefine meaningless symbols to meaningful terms is to be counted as creative talent.

**Semantic Redefinition: Object Synthesis**

This is a modified form of Guilford’s Semantic Redefinition: Object Synthesis. Redefinition means the ability to perceive in a way different from the established way. A semantic test require the examinee do find new meanings to the details given. The subject has to make proper alterations for the given figure to redefine it to a meaningful pattern.
Semantic Elaboration: Figure Production

This task is directly taken from Guilford's Semantic Elaboration: Figure Production. Elaboration means giving more details about a simple concept. Score is based on number of details drawn.

An example is mentioned below.

Make a drawing on 'Science a bliss or a curse.'

Part E- Sensitivity to Problems

Sensitivity to Problems: Seeing Deficiencies

This is an adaptation of Guilford's Sensitivity to Problem: seeing Deficiencies. This task is to point out the way in which a described activity is faulty.

An illustrative item is given below.

Point out the problems due to the following activity.

Paddy fields are levelled for constructing buildings.

Sensitivity to Problems: Seeing Problems

This is directly adapted from Guilford's Sensitivity to Problems: Seeing Problems. Here, the subject is to list problems that might arise in connection with common objects.

Example for this task is given below.

What problems may arise due to the use of 'soft drinks'?

Sensitivity to Problems: Apparatus Test

This is directly adapted from Guilford's Sensitivity to Problems: Apparatus Test. The subject is required to suggest improvements to the
common appliances. The suggestions are expected to be interesting and unusual and need not be practicable in the acceptable sense of the term.

Example for this item is given below.

Suggest improvements for Mobile phone.

Details of the items selected for each task is presented in Table 3.3.

**Table 3.3**

<table>
<thead>
<tr>
<th>PART</th>
<th>Component</th>
<th>Factor</th>
<th>Tasks</th>
<th>No. of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Fluency</td>
<td>World Fluency</td>
<td>Prefixes</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Suffixes</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ideational Fluency</td>
<td>Topics IF-1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Topics IF-2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Associations</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>B</td>
<td>Flexibility</td>
<td>Semantic Spontaneous Flexibility</td>
<td>Alternatives</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Match Problems</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>Originality</td>
<td>Novelty</td>
<td>Remote Consequences</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Picture Completion</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Plot Titles</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Imaginative Stories</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Just Suppose</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Multiplicity</td>
<td>Identification and Illustration</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Suggestions</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Multiple Grouping</td>
<td>2</td>
</tr>
<tr>
<td>D</td>
<td>Elaboration and Redefinition</td>
<td>Figural Redefinition</td>
<td>Concealed Phenomena</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Symbolic Redefinition</td>
<td>Camouflaged Word</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Semantic Redefinition</td>
<td>Object Synthesis</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Semantic Elaboration</td>
<td>Figure Production</td>
<td>1</td>
</tr>
<tr>
<td>E</td>
<td>Sensitivity to Problems</td>
<td>Sensitivity to Problems</td>
<td>Seeing Deficiencies</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Seeing Problems</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Apparatus Test</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>84</strong></td>
</tr>
</tbody>
</table>
All the general instructions about the test, explaining clearly the nature of the test and what is expected of the subjects, were given on the facing sheet. Then specific instructions along with illustrative examples were given clearly at the beginning of each type of item. The test material was printed as a booklet. Separate answer sheets were prepared. Copy of the draft test is given as Appendix A.

**Tryout**

Tryout of the test is to select good items for the final form of the test and to know exactly how the test will function in actual use. The tryout is to serve the following purposes:

(i) To fix a suitable time limit for each part.

(ii) To examine the adequacy and clarity of the instructions and the effectiveness of the items given.

(iii) To decide the improvements in the test administration procedure.

(iv) To eliminate items, if any, for which the average frequency count of responses is very low, because it is essential that the items should be capable of arousing large number of responses easily.

(v) To decide the extent of space for answering.

**Sample for Tryout**

A representative sample of 620 pupils of Higher Secondary Schools of Kollam, Kottayam and Pathanamthitta districts were chosen for trying out the test. In selecting the sample, care was taken to give representation to
gender, locality, and nature of the school (government/private). Details regarding the schools selected for the tryout are given in Table 3.4.

Table 3.4

<table>
<thead>
<tr>
<th>St.No.</th>
<th>Name of School</th>
<th>Boys/Girls/ Mixed</th>
<th>Rural/Urban</th>
<th>Govt./Private</th>
<th>No of Boys</th>
<th>Girls</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Govt. H.S.S., Kalanjoor, Pathanamthitta</td>
<td>Mixed</td>
<td>Rural</td>
<td>Govt.</td>
<td>36</td>
<td>23</td>
<td>59</td>
</tr>
<tr>
<td>2</td>
<td>Govt. H.S.S., Koodai, Pathanamthitta</td>
<td>Mixed</td>
<td>Rural</td>
<td>Govt.</td>
<td>28</td>
<td>24</td>
<td>52</td>
</tr>
<tr>
<td>3</td>
<td>Govt. H.S.S., Kottarakkara, Kollam.</td>
<td>Mixed</td>
<td>Urban</td>
<td>Govt.</td>
<td>24</td>
<td>26</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>Govt. H.S.S., Changanassery, Kollam.</td>
<td>Mixed</td>
<td>Urban</td>
<td>Govt.</td>
<td>29</td>
<td>29</td>
<td>58</td>
</tr>
<tr>
<td>5</td>
<td>St. Berchmanns H.S.S., Changanassery, Kollam.</td>
<td>Boys</td>
<td>Rural</td>
<td>Pvt.</td>
<td>61</td>
<td>0</td>
<td>61</td>
</tr>
<tr>
<td>6</td>
<td>St. John's H.S.S., Nedumkunnam, Kollam.</td>
<td>Mixed</td>
<td>Rural</td>
<td>Pvt.</td>
<td>22</td>
<td>25</td>
<td>47</td>
</tr>
<tr>
<td>7</td>
<td>St. Teresa's H.S.S., Changanassery, Kollam.</td>
<td>Mixed</td>
<td>Urban</td>
<td>Pvt.</td>
<td>48</td>
<td>44</td>
<td>92</td>
</tr>
<tr>
<td>8</td>
<td>St. Joseph's H.S.S., Changanassery, Kollam.</td>
<td>Girls</td>
<td>Urban</td>
<td>Pvt.</td>
<td>0</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td>9</td>
<td>Govt. H.S.S., Punalur, Kollam.</td>
<td>Mixed</td>
<td>Urban</td>
<td>Govt.</td>
<td>47</td>
<td>43</td>
<td>90</td>
</tr>
<tr>
<td>10</td>
<td>St. Stephen's H.S.S., Pathanaparam, Kollam.</td>
<td>Mixed</td>
<td>Rural</td>
<td>Pvt.</td>
<td>28</td>
<td>23</td>
<td>51</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>323</td>
<td>288</td>
<td>612</td>
</tr>
</tbody>
</table>

Administration of the Test

After obtaining permission from the heads of the institutions, the date and time for the test was fixed. The investigator administered the test with the help of the science teachers of the schools.
Emotional climate of the class is of much significance when a creativity tool is administered. Students would express their imaginative ideas freely if there exists a friendly atmosphere in the classroom. Hence, a non-threatening, relaxed and game like environment was organised by means of a free and humorous approach. Thus, a good rapport was established before the commencement of the test.

The following steps were followed for administering the test:

(i) Distribution of the test booklets to the subjects.
(ii) Explaining the general instructions in the booklet.
(iii) Distribution of the answer sheets with necessary instructions.
(iv) Making the students familiar with the examples given and directing them to answer all the items accordingly.
(v) Provide enough time to complete the test.
(vi) Clearing the doubts of subjects.
(vii) Collecting back the booklets and response sheets.

**Scoring**

A scoring scheme was prepared by scoring the items for Fluency, Flexibility and Originality.

**Scoring Scheme for Fluency**

An individual score for fluency was determined by counting the total number of right relevant and unrepeated responses. One point credit was given to each response. Thus, the total score for fluency for each item was found out.
Scoring Scheme for Flexibility

Flexibility in Scientific Creativity is represented by the ability to solve scientific problems through different approaches. These approaches are classified into categories and the nature of categories varied form subtest to subtest. One score is assigned for each category if at least one response came under it. No additional score is assigned for more than one response in a category.

Scoring Scheme for Originality

Originality means the uniqueness of responses. It is based on different degree of uncommonness. The scores vary from four to zero as given in Table 3.3. The score thus obtained for each item is summed up to get the total score for Originality.

The sum of the scores for Fluency, Flexibility and Originality gives the scores of Scientific Creativity. The scores for verbal items give the scores of Verbal Scientific Creativity and that for figural items given the scores of Non-Verbal Scientific Creativity.

Table 3.5
Scoring Scheme for Originality

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Grouping in terms of Uncommonness of Responses</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Responses given by less than 1% in the sample</td>
<td>4</td>
</tr>
<tr>
<td>(ii)</td>
<td>Responses given by 1% to 2% in the sample</td>
<td>3</td>
</tr>
<tr>
<td>(iii)</td>
<td>Responses given by 2% to 5% in the sample</td>
<td>2</td>
</tr>
<tr>
<td>(iv)</td>
<td>Responses given by 5% to 12% in the sample</td>
<td>1</td>
</tr>
<tr>
<td>(v)</td>
<td>Responses given by 12% and more in the sample</td>
<td>0</td>
</tr>
</tbody>
</table>
Scoring Process

The scoring process was time consuming since each item had to be scored three times as mentioned below.

(i) Number of responses were counted and fluency score was assigned.
(ii) Categorisation of the responses examined and flexibility score was assigned.
(iii) Uncommon nature of the responses was examined and originality score was assigned.

A score sheet was prepared for entering the scores of Fluency, Flexibility, Originality, Verbal Scientific Creativity, Non-verbal Scientific Creativity and Total Scientific Creativity.

Item Analysis

Item analysis refers to the application of statistical techniques to assess two characteristics of items, their difficulty and the extent to which they are correlated with other measures (Wood, 1960, p.81).

Item analysis helps the investigator to make a test valid and reliable. Validity and reliability can both be improved through the selection and revision of items. Other things being equal, a longer test would be more valid and reliable than a shorter test. However, when a test is shortened by eliminating the least satisfactory items, the shorter version will be more valid and reliable.

Gulliksen (1950), Guilford (1954), Garrett (1959) and Edward (1969) have favoured employing item analysis for improving the reliability and validity of tests. Item analysis primarily concerns with item difficulty and item
discrimination. Item difficulty was taken in terms of the proportion of individuals completing the item successfully and item discrimination index refers to the degree to which it differentiates between those obtaining high scores and those obtaining low scores on the test.

In the construction of the present test of Scientific Creativity, item difficulty could not be determined in the conventional way because the items in the tests of Scientific Creativity demanded responses of divergent nature. So, the method suggested by Edward (1969) was followed for item analysis.

The responses were scored using the scoring scheme. The scores obtained for each item and the total scores for each individual were marked. On the basis of the total scores obtained, the scores of 590 response sheets were arranged in the descending order of marks. Remaining papers were incomplete and rejected. Then the top 160 papers (27%) and bottom 160 papers were identified as papers of upper and lower criterion groups. Then 't' value was calculated using the formula

\[ t = \frac{\bar{X}_H - \bar{X}_L}{\sqrt{\frac{\sum (X_H - \bar{X}_H)^2 + \sum (X_L - \bar{X}_L)^2}{n(n-1)}}} \]

where

\( \bar{X}_H \) = Mean score of an item for the high group

\( \bar{X}_L \) = Mean score of an item for the low group

n = number of cases
Those items for which significant differences were noticed are selected for the final test. Items yielding the highest critical ratios were given preferences.

**Preparation of the Final Test**

The better discriminating items were selected for the final test. Thus, a total number of 52 items were selected.

The format of the final test was exactly the same as the one used for the draft test. Sufficient number of copies of the final test was made ready for the final administration. Separate answer sheets were also printed. Copy of the final test is given as Appendix C.

**Time Limit for the Final Test**

The time limit for each part was fixed as given in Table 3.6.

<table>
<thead>
<tr>
<th>Part</th>
<th>Time in Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>24</td>
</tr>
<tr>
<td>B</td>
<td>7</td>
</tr>
<tr>
<td>C</td>
<td>28</td>
</tr>
<tr>
<td>D</td>
<td>15</td>
</tr>
<tr>
<td>E</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>83</td>
</tr>
</tbody>
</table>

The details regarding the tasks, the number of items selected and the time allotted for each for the final test are given in Table 3.7
## Table 3.7

Details regarding the Items in the Scientific Creativity Test (Final Test)

<table>
<thead>
<tr>
<th>Part</th>
<th>Component</th>
<th>Factor</th>
<th>Tasks</th>
<th>No. of Items</th>
<th>Time in minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Fluency</td>
<td>World Fluency</td>
<td>Prefixes</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Suffixes</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ideational Fluency</td>
<td>Topics IF-1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Topics IF-2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Associational Fluency</td>
<td>Associations</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>B</td>
<td>Flexibility</td>
<td>Semantic Spontaneous Flexibility</td>
<td>Alternatives</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Figural Adaptive Flexibility</td>
<td>Match Problems</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>Novelty</td>
<td></td>
<td>Remote Consequences</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Picture Completion</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Plot Titles</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Imaginative Stories</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Identification and Illustration</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Suggestions</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Multiplicity</td>
<td>Multiple Grouping</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Elaboration and Redefinition</td>
<td>Figural Redefinition</td>
<td>Concealed Phenomena</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Symbolic Redefinition</td>
<td>Camouflaged Word</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Semantic Redefinition</td>
<td>Object Synthesis</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Semantic Elaboration</td>
<td>Figure Production</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>E</td>
<td>Sensitivity to Problems</td>
<td>Sensitivity to Problems</td>
<td>Seeing Deficiencies</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Seeing Problems</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Apparatus Test</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td></td>
<td>52</td>
<td>83</td>
</tr>
</tbody>
</table>
Evaluating the Test

Evaluating the test means checking the most important requirements of a test in terms of Validity and Reliability.

Validity

The validity of a test concerns what the test measures and how will it does so. The trait measured by a given test can be defined only through an examination of the objective sources of information and empirical operations utilised in establishing the validity (Anastasi, 1997, p.113).

The test possess construct validity to a reasonably high degree due to the theory used in the development of the test, tasks included, selection of discriminating items, etc.

Evidence in terms of the internal consistency of the components of Scientific Creativity has been examined for the sample for tryout. The components have been found to be correlated positively and significantly with one another. Each of the components correlates considerably with the Total Scientific Creativity Test scores, the coefficients vary from 0.6543 to 0.8123, the average correlation being 0.76391. The details are presented below in Table 3.8
Table 3.8
Inter correlation among Fluency, Flexibility, Originality and Scientific Creativity

<table>
<thead>
<tr>
<th></th>
<th>X1</th>
<th>X2</th>
<th>X3</th>
<th>X4</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X2</td>
<td>0.7342</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X3</td>
<td>0.6543</td>
<td>0.6981</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>X4</td>
<td>0.7814</td>
<td>0.8123</td>
<td>0.7540</td>
<td>1.000</td>
</tr>
</tbody>
</table>

X1 – Fluency  X3 – Originality
X2 – Flexibility  X4 – Scientific Creativity

The above table shows that all the correlations are positive and significant, thus it justifies the selection of Fluency, Flexibility and Originality as the Scientific Creativity components for the study.

Reliability

A reliable measure is one that provides consistent and stable indications of the characteristic being investigated (Anderson et al., 1976, p.325).

The reliability of the present test was established using test-retest method. The test-retest time was one month. The test-retest reliability coefficient was found to be 0.83. This value of obtained ‘r’ shows that the test is a reliable one.

Thus, it may be concluded that since the test has sufficient validity and reliability, the prepared tool is apt for measuring Scientific Creativity of Higher Secondary Pupils.
3.3.2 Measurement of Intelligence

Intelligence Test

To measure the Intelligence of Higher Secondary school pupils, two procedures were adopted using two tools.

3.3.2.1 Verbal Test of Intelligence

3.3.2.2 Non-verbal Test of Intelligence

3.3.2.1 Verbal Test of Intelligence

To measure the verbal intelligence of the subjects, the investigator selected an available tool, Kerala University Group Test of Intelligence for Adults.

Kerala University Group Test of Intelligence for Adults (Revised Version)

This test was designed by Anandavalliamma for measuring the General Intelligence of Adults. The test contains five subtests as Verbal Analogy, Verbal Classification, Numerical Reasoning, Letter Matrices and Spatial Reasoning. The total time for the test is 40 minutes.

Of the five subtests, four are in the verbal form and last subtest is in figural form. Since the present study envisages the use of a separate Non-verbal Intelligence test, the fifth subtest was not used for measuring the Verbal Intelligence, since it was in non-verbal form.

The illustrative items of the subtests are given below.

Subtest I- Verbal Analogy

This items presents three words in a particular order. The examinee is required to infer a missing fourth word in the sequence from the three words
given. The first two words in the sequence are related to each other in a particular way. The implied relation has to be found out and applied to the third word in order to find out the missing fourth word.

Example:

   (a) Fly; (b) Black (c) Wings (d) Bird

   (a) Cloud; (b) Blue (c) Air (d) Sun

**Subtest II: Verbal Classification**

Each item of this test contains five words. Four of these words can be grouped together on the basis of some relationship or principle, while one word will 'stand out', or will not fit into the group. The task is to find out the word which does not belong to the group.

Example:

1. (a) Lion (b) Crow (c) Cat (d) Dog (e) Cow

2. (a) Chair (b) Table (c) Man (d) Desk (e) Shelf

**Subtest III: Numerical Reasoning**

Each item consists of a sequence of numbers, formed according to some particular rule. One of the numbers in the sequence is missing. The task is to examine the given numbers, find out the rule which the numbers in the sequence follow, and use this rule to guess the missing number. The correct answer has to be identified from the given four alternatives.
Examples:

1. 1, 4, 7, 13, 16
   (a) 11  (b) 10  (c) 9  (d) 12

2. 1, 2, 4, 8
   4, 8, 16, 32
   (a) 16  (b) 12  (c) 16  (d) 16
   32  48  48  64

Subtest IV: Letter Matrices

In each item, there are nine cells arranged in three rows and three columns. Eight of these cells are filled with letters of English alphabet, while the bottom right-hand corner cell is empty. The task is to find out the letter or letters which will complete the design. Four alternatives are given from which the correct answer has to be selected.

1. 2.

<table>
<thead>
<tr>
<th>P</th>
<th>Q</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>R</td>
<td>S</td>
</tr>
<tr>
<td>R</td>
<td>S</td>
<td></td>
</tr>
</tbody>
</table>

(a) S, (b) T, (C) R, (D) P

(a) EF (b) GH (C) EF (d) AB

Validity and Reliability

The reported validity of the test is as follows. With Raven's Progressive Matrices Test as external criterion, the correlation coefficient
obtained was 0.760 which shows that the test is a reasonably good test for measuring the Intelligence.

The reported reliability of the test estimated by split-half method is as follows. The split-half coefficient for the whole test is 0.890, Verbal Analogy = 0.775, Verbal Classification = 0.650, Numerical Reasoning = 0.650, Letter Matrices = 0.820 and Spatial Reasoning = 0.717. These reliability coefficients are significant which shows that the test is reliable.

The investigator established the validity and reliability of the test to select this tool for the present study.

Split half method was employed to find out the reliability of the test. A sample of 350 Higher Secondary School students (selected from the sample for tryout of Scientific Creativity test) were subjected to the Intelligence Test. The test scores were divided to two halves. The first set of scores represent scores for the odd number of items 1, 3, 5, etc and the second set of scores present scores on the even number of items 2, 4, 6, etc. Self correlation of the half tests was found out and then the reliability coefficient of the whole test was estimated by Spearman-Brown Prophecy formula (Garrett, 2004, p.339).

The value of reliability coefficient thus obtained for the subtests are given in Table 3.9.
Table 3.9

Split-half Reliability Coefficients of Subtests of Verbal Intelligence

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Subtests</th>
<th>Reliability Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Verbal Analogy</td>
<td>0.82</td>
</tr>
<tr>
<td>2.</td>
<td>Verbal Classification</td>
<td>0.84</td>
</tr>
<tr>
<td>3.</td>
<td>Numerical Reasoning</td>
<td>0.80</td>
</tr>
<tr>
<td>4.</td>
<td>Letter Matrices</td>
<td>0.87</td>
</tr>
<tr>
<td>5.</td>
<td>Whole Test</td>
<td>0.89</td>
</tr>
</tbody>
</table>

The test has been validated against the marks obtained for class X as external criterion. The validity coefficients obtained are given in Table 3.10.

Table 3.10

Validity Coefficients of Subtests of Verbal Intelligence

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Subtests</th>
<th>Reliability Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Verbal Analogy</td>
<td>0.67</td>
</tr>
<tr>
<td>2.</td>
<td>Verbal Classification</td>
<td>0.58</td>
</tr>
<tr>
<td>3.</td>
<td>Numerical Reasoning</td>
<td>0.72</td>
</tr>
<tr>
<td>4.</td>
<td>Letter Matrices</td>
<td>0.72</td>
</tr>
<tr>
<td>5.</td>
<td>Whole Test</td>
<td>0.69</td>
</tr>
</tbody>
</table>

The details provided above reveal that the selected Test of Intelligence is reasonably good for measuring Verbal Intelligence of Higher secondary School students.

3.3.2.2 Non-verbal Test of Intelligence

Non-verbal Test of Intelligence is used to measure the non-verbal intelligence related to figural perceptions. The investigator selected Raven's
progressive Matrices Test for measuring the non-verbal intelligence of higher secondary students.

**Raven's Progressive Matrices Sets A, B, C, D and E**

This is a non-verbal group test for measuring a person’s capacity at the time of the test to apprehend meaningless figures presented for his observation, see the relations between them, conceive the nature of the figures completing each system of relation presented, and thus develop a systematic method of reasoning (Raven, 1960, p.1).

This scale consists of 60 problems divided into five sets of 12 each. In each set, the first problem is as nearly as possible self-evident. The problems which follow become progressively more difficult. The order of the tests provides the standard training in the method working. The five sets provide five opportunities for grasping the method and give progressive assessments of a person’s capacity for intellectual activity. Part of a figure is removed in each item and a number of alternatives (six for the first two sets A and B and eight for the last three sets C, D and E) are given from which the correct answer has to be chosen.

These tests are intended to evaluate the person’s ability to discern and utilise a logical relationship presented by non-verbal materials. The problem requires, in varying degrees, analytical and integrating operations of the kind called ‘insight through visual survey’. Each problem in the scale is the source of a system of thought and hence the name ‘progressive matrices’. The scale is intended to cover the whole range of intellectual development from the time
a child is able to grasp the idea of finding a missing piece to complete a pattern and to be sufficiently long to assess a person's maximum capacity to form comparison and reason by analogy without being unduly exhausting or unwieldy.

As reported by Raven, the test has a retest reliability varying from 0.83 to 0.93. It correlates 0.86 with the Terman-Merrill Scale and has been found to have a 'g' saturation of 0.82.

This test is a popular measure used in Indian schools. This tool is of good standard items and it may be used for Higher Secondary School students to measure their Intelligence.

The investigator employed test-retest method to find out the reliability of the test. The test was administered to 350 students of Standard XI and retest was conducted after one month. The test-retest reliability coefficient was found to be 0.89. So, the test is a reliable one.

The test has been validated against the marks obtained for class X as external criterion. The validity coefficient obtained is 0.71.

The test is reasonably reliable and valid to measure the Non-verbal Intelligence of Higher Secondary School students.

3.3.3 Measurement of Achievement Motivation

3.3.3.1 Achievement Motivation Scale

To assess the Achievement Motivation of the sample, a tool was selected namely Kerala Scale of Achievement Motivation. Though the tool was prepared in 1976, the items of the scale have still relevance with regard
methodology
to the motivational implications of Higher Secondary School students. The investigator felt that the statements included in the scale would be more meaningful for adolescent students than secondary school students. Each statement has a direct link with the achievement-oriented thoughts of an adolescent. So, the Kerala Scale of Achievement Motivation was chosen to assess the Achievement Motivation of Higher Secondary School students.

3.3.3.2 Kerala Scale of Achievement Motivation

The scale developed by Nair (1976) has 60 items in the form of statements intended to measure the Achievement Motivation of subjects.

The subjects are to respond to the items by marking either Y (Yes), U (Undecided) or N (No) on the response sheet supplied. Each Y responses carries one credit. There is no time limit for the test.

Example of a statement is given below.

1. What others think of me won't be an obstacle to my success in life.
2. I feel tired when I have to perform very important things.

Validity and Reliability

The reported validity coefficients with school marks as external criterion were found to be 0.38 (N = 47, standard VIII), 0.44 (N = 38, standard IX) and 0.39 (N = 42, standard X). The established reliability of the scale was 0.73 (N = 56).

To apply the scale with Higher Secondary School students, the investigator examined its validity and reliability. The test-retest reliability
coefficient obtained is 0.79 (N = 350). When the scale was validated against
the final examination marks of class X, the validity coefficient obtained is 0.40.

The details provided above indicate that the Kerala Scale of
Achievement Motivation is a reasonably good tool to assess the Achievement
Motivation of Higher Secondary School students.

3.3.4 Measurement of Home Environment

3.3.4.1 Home Environment Inventory

Higher Secondary school period being the most crucial stage that
forces a student to interact positively and negatively with his home, the
physical and emotional set up of the home is to be analysed. The investigator
went through the available tools for measuring Home Environment of
students. It was found that the major aspects of a home that influences
higher secondary school students were not considered in those tests. So, the
investigator constructed a tool by incorporating the theoretical model adopted
in the existing tools.

Development of Tool

Following tools helped the investigator for the preparation of the
present tool. (a) Minnesota Counselling Inventory, (b) Family Climate
Inventory, (c) Family Integration Inventory (d) Family Environment Index
Inventory. The investigator got many opportunities to interact with Higher
Secondary School students and their parents during counselling sessions
specially arranged by the Parent Teacher Associations (PTA) of various
schools. Major components of the home that directly influence the
achievement of Higher Secondary School students were identified and these were grouped to six categories as given below.

I. Physical Facilities for Learning

II. Guidance for Learning

III. Socio-cultural Environment of the Home

IV. Family Cohesion

V. Value Orientation of the Home Members

VI. Emotional Support

I. **Physical facilities for Learning**

As far as Higher secondary School science students are concerned, certain basic facilities are essential for effective learning. Facilities like scientific calculator, computer, internet, etc. are helpful for promoting learning. This section deals with physical facilities available at home. Two representative items are given below.

Following facilities that promotes learning are available in my home.

<table>
<thead>
<tr>
<th>Always</th>
<th>Sometimes</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Computer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Internet</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

II. **Guidance for Learning**

Proper encouragement for learning is essential during the adolescent stage. Even though enough physical facilities are present, it is true that children try to misuse television, computer, internet, etc. So, proper guidance and support from the family members is necessary for Academic
Achievement. Whenever the students feel confused in academic and personal problems they need timely help. Example for this item is given below.

My family members provide the following helps.

Always Sometimes Never

(1) Clear doubts in various subjects
(2) Tuition for difficult subjects

III. Socio-cultural Environment of the Home

The cultural and social conditions of the family has definite influence on the academic achievement of a student. The quarrelling parents, noisy neighbourhood, disorganised home relations, poverty, etc. affects the intellectual progress of an individual adversely. An adolescent living in deprived and impoverished conditions of life lacks the basic stimulation and motivation to learn. If the cultural demands and social expectations of the family is conducive for learning, it paves the way for good scholastic achievement of children.

Illustrative items are as follows:

Following situations of my home make problems that negatively affecting my studies.

Always Sometimes Never

1. Economic backwardness
2. Noisy surrounding
IV. Family Cohesion

A good family where exist cordial relationship can provide the child a congenial atmosphere for learning. The adolescent members of such family find themselves to cope up with difficult situations. Thus, a healthy relationship between the family members is preferable for acquiring academic excellence. The degree of family cohesion experienced by the student as a member of the family is measured here.

Examples of items are:
Following occasions are present in my home:

<table>
<thead>
<tr>
<th>Always</th>
<th>Sometimes</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Praying together</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Conducting picnics</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

V. Value Orientation

The value system prevailing in the home is an essential component in modelling the personality of adolescents and in monitoring achievements. The negative values shown by parents are a major cause of crime and delinquency among adolescents. If children are exposed to good values at home, they are motivated to follow up what they observe at home.

During Higher Secondary stage, the students have a tendency to experiment with many social evils and so special care is to be taken for directing them in the proper channel. This part of the test measures the extent of value orientation they absorb from home.

Examples for test items are given below.
Methodology

My parents provide encouragement for me to do the following activities:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Always</th>
<th>Sometimes</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helping the poor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading good books</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

VI. Emotional Support

It is obvious that the adolescent students have many emotional problems and difficulties. The emotional inability and maladjustment causes too many failures during this developmental stage. The nature of discipline at home, expression of love by family members, approval for success, etc. have great influence upon the emotional intelligence of the child. Presence of a relaxed atmosphere is necessary for proper emotional development. Excessive pressure for study, sarcasm or ridicule by parents, inhumane punishments and rejection should be avoided in the home since these may hurt the feelings of an adolescent student. This part of the test is to measure the extent of emotional protection and support provided by the home.

Example for test items is given below.

Following situations are present in my home:

<table>
<thead>
<tr>
<th>Situation</th>
<th>Always</th>
<th>Sometimes</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Expression of love and happiness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Console in a grief or depression</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Scoring

The items in the inventory are arranged in the form of a rating scale. The response to each item is made by putting a tick mark against the relevant
rating point. The items are scored by assigning scores 0, 1, 2 to tick marks Never, Sometimes and Always respectively. Negative items will be scored in the reverse order. The score for Home Environment is the sum total of all the scores obtained.

Selection of Items in the Inventory

The items for Home Environment Inventory were selected on the basis of the six categories described earlier. Initially, the investigator prepared 75 items for the inventory. The most suitable and relevant items were selected by seven experts in the field of Sociology, Education and Psychology.

A tryout of the inventory was administered on the same sample used for the tryout of Scientific Creativity Test. Response sheets of 590 students were collected. The upper and lower groups (160 each) identified were analysed for selecting the best items.

For every item, number of students who gave the relevant responses in the upper group and number of students who gave the relevant responses in the lower group were noted. The discriminating power was calculated using the formula

\[
\text{Discriminating Power} = \frac{U - L}{N} \quad \text{Where}
\]

\[
U = \text{the number of students who gave relevant responses in the upper group}
\]

\[
L = \text{the number of students who gave relevant responses in the lower group}
\]

\[
N = \text{Number of students in each group.}
\]
Those yielding highest discriminating power were selected for the final tool.

**Validity and Reliability**

The construct validity and concurrent validity have been assured in terms of the definition and representation given to the concept under measurement.

The scores of the inventory for a sample of 350 Standard XI students were correlated with the final examination marks of class X. A correlation of 0.72 is obtained.

The split-half reliability coefficient obtained is 0.79. These details show that the inventory is a reasonably valid and reliable instrument for measuring the Home Environment of Higher Secondary School students.

### 3.3.5 Measurement of Achievement in Science

In the present study, Achievement in Science denotes Achievement in Physical Science. The scores obtained for Physics and Chemistry for the annual examination of Standard XI were collected. These scores were then converted to standard scores by changing raw scores to derived scores.

Here, the raw scores were converted to T-scores using the equation

\[ T = \frac{10(X - M)}{\sigma} + 50 \]

where

- \( X \) = raw score
- \( M \) = Arithmetic mean of raw score
- \( \sigma \) = Standard deviation of raw scores
3.4 SAMPLE USED FOR THE STUDY

The population for the present study is pupils attending Standard XI in
the Higher Secondary Schools of Kerala. Treating this as the reference
population, the sample was fixed by taking into consideration, the following
factors:

3.4.1 Size of the Sample

3.4.2 Techniques of Sampling

3.4.3 Factors to be represented in the Sample

3.4.1 Size of the Sample

An optimum sample is one which fulfils the requirements of efficiency,
representativeness, reliability and flexibility. The sample should be small
enough to avoid unnecessary expenses and large enough to avoid intolerable
sampling error.

According to Krech and Crutchfield (1948, p.298), a sample of 500 will
give just about as precise results a study as it will be for the whole population.

In this study, a sample of 1200 Higher Secondary School students
were selected.

3.4.2 Techniques of Sampling

If a population from which a sample is to be drawn does not constitute
a homogenous group, stratified sampling technique is generally applied in
order to obtain a representative sample (Kothari, 1998, p.62). So, stratified
sampling was used to get representative sample of Higher Secondary School
students.
3.4.3 Factors to be represented

Due representation is to be given to the basic factors which would possibly influence the performance of pupils. As such, it was decided to give representation to the following categories in the sample selection.

(a) Boy, girls

(b) Pupils studying in Rural schools, Urban schools

(c) Pupils studying in Government schools, Private schools

On the basis of above considerations, it was decided to confine the study to 1200 standard XII students of Higher Secondary schools. This sample was selected from four districts of Kerala, namely Kottayam, Pathanamthitta, Kollam and Alappuzha.

Table 3.11 shows the break-up of the final sample.

Table 3.11

Break-up of the Final Sample

<table>
<thead>
<tr>
<th></th>
<th>Boys</th>
<th>Girls</th>
<th>Rural</th>
<th>Urban</th>
<th>Government</th>
<th>Private</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>557</td>
<td>563</td>
<td>571</td>
<td>549</td>
<td>535</td>
<td>585</td>
</tr>
<tr>
<td>Total</td>
<td>1120</td>
<td>1120</td>
<td>1120</td>
<td>1120</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Details regarding the schools selected for the final test are given in Appendix I.
3.5 COLLECTION OF DATA

After finalising the sample and tools to be used, the investigator met the Heads of the schools and the teachers and had discussions with them. Dates and time was fixed and most of the teachers allotted the whole afternoon periods for the administration of the tools.

Uniform procedures were followed in all the schools selected. This include the following aspects:

(i) Distribution of the answer sheets to the subjects with instructions for filling them up.

(ii) Distribution of the test booklets together with printed instructions regarding the test.

(iii) Explaining the general instructions in the booklet.

(iv) Familiarising the subjects with the answer sheets, method of entering responses, etc.

(v) Clearing the doubts of subjects, giving instructions regarding time-limit, methods of dealing with eventualities, etc.

(vi) Strict adherence to the time limit prescribed in the test booklet.

(vii) Giving directions not to disfigure the test booklets.

(viii) Giving intervals between tests.

(ix) Collecting back the test booklets and answer sheets.
3.5.1 Scoring

The response sheets of all the tests were scored as per the scoring scheme of the test described earlier along with each test. Scoring was a lengthy process for the Scientific Creativity Test compared to other tests.

3.5.2 Consolidation of Data

All the relevant data relating to each pupil (Sex, Management of the Institution, Locality, test scores in each test, etc.) were entered separately in corresponding rows and columns of specially designed papers. The data was entered in such a way that they could be used for computer data processing.

A total of 1224 answer sheets were obtained. From this, 64 answer sheets were incomplete and a few failed to attend all the tests. Eliminating these, data pertaining to 1120 sample were used for analysis.

3.5.3 Selection of High Achievement Group (HA), Average Achievement Group (AA) and Low Achievement Group (LA)

Based on the scores in the Achievement in Science, the subjects were grouped into three, viz., High, Average and Low. The Mean M and Standard Deviation $\sigma$ of the distribution of scores on Achievement in Science for the whole sample was determined. The subjects whose scores were at or above $M + \sigma/2$ were grouped as High group and those scores were at or below $M - \sigma/2$ were grouped as Low. Those subjects whose scores were in between $M - \sigma/2$ and $M + \sigma/2$ were grouped as Average.
3.6 STATISTICAL TECHNIQUES USED

The objectives of the study and specific hypotheses to be tested suggest the use of the following techniques for analysis.

1. Two-tailed test of significance of the difference between means for large independent groups (Critical Ratio) to compare the three Achievement groups HA, AA and LA taken in pairs (HA-AA, AA-LA and HA-LA) with respect to each independent variables.

2. Pearson’s Product Moment Coefficient of Correlation to find the relationship among the variables.

3. Multiple Regression Equation to predict Achievement in Science using the best predictors of Achievement.

4. Multiple Coefficient of Correlation to find out the combined effect of predictor variables on Achievement in Science.