Chapter IV

METHODOLOGY
4.1 INTRODUCTION

Methodology of investigation is the core of every research work and the success of all research studies depends on the methodology adopted and the tools and techniques employed. A pre-planned and well designed methodology provides the researcher a scientific and feasible plan for solving the problem under analysis. According to Barr, Davis and Johnson (1953), after a problem has been defined and delimited, the materials, methods and scope of the investigation requiring use of the quantitative method, statements should be made of the number and kinds of subjects used, the instruments employed and other kinds of information. It helps the researcher to explore different trends in the field and adequately measure them so as to satisfy the requirement of the investigation.

The method adopted, the data gathering instruments, the selection of sample, the procedure of data collection and the outline of statistical techniques employed in analysis of data are described under appropriate head as presented below;

1. Method adopted for the study.
2. Sample for the study.
3. Tools used for the study.
4. Description of Tools.
5. Procedure for Data collection and final testing of the study.
6. Statistical techniques used in the study.

4.2 METHOD ADOPTED FOR THE STUDY

The selection of a method and the specific design within the method appropriate to the research problem will depend upon the nature of the problem
and upon the kind of data. Considering the different aspects of the study the investigator had decided to adopt Normative Survey method for the present study, an important method in descriptive research. The word ‘Survey’ indicates the gathering of data regarding current conditions. It attempts to describe and interpret what exists at present in the form of conditions, practices, trends, effects, beliefs, attitude etc. The word ‘Normative’ is used because surveys are frequently made for the purpose of ascertaining which the normal or typical condition or practice at the present time. Thus, the Normative Survey method attempts to find out the normal or typical conditions or practice existing currently.

4.3 SAMPLE FOR THE STUDY

The selection of a sample is an integral part of research. It governs the reliability and dependability of the result obtained. A good sample of a population is one, which will reproduce the characteristics of the population with great accuracy. The population of the present study consisted of Upper Primary school students of Kerala following State syllabus, by giving due representation to Gender (Boys and Girls), Locale (Rural and Urban) and Type of Management (Government, Aided and Unaided) from two districts of Kerala state (Kollam and Trivandrum).

4.3.1. Techniques of sampling

The Stratified Random sampling technique is widely accepted as the best procedure when heterogeneous samples have to be brought under study. This technique is designed to ensure representativeness for all strata and to avoid bias. The scheme is applicable when the population is composed of sub-groups or strata of different sizes, so that the representative sample must contain individuals drawn
from each category or stratum in accordance with the size of sub-groups (Garret, 2004; p. 206).

4.3.2. The Initial sample

On the basis of characteristics of population, an initial break-up of a tentative sample was worked out and it was decided to cover a basal sample of thousand and one hundred and fifty (1150) students. The break-up of the initial sample in terms of Gender, Locale of Institution and Type of Management was estimated as given in Table 4.1

**TABLE 4.1**

*The break-up of the initial sample in terms of Gender, Locale of Institution and Type of Management*

<table>
<thead>
<tr>
<th>Gender</th>
<th>Locale</th>
<th>Type of Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>Girls</td>
<td>Rural</td>
</tr>
<tr>
<td>552</td>
<td>598</td>
<td>576</td>
</tr>
<tr>
<td>1150</td>
<td>1150</td>
<td>1150</td>
</tr>
</tbody>
</table>

The details given in the Table 4.1 indicate that the sample consists of 552 Boys and 598 Girls students of which 576 were from Rural setting and 574 from Urban setting. With respect to Type of Management of the school, 355 from Government schools, 400 from Aided schools and 395 from Unaided schools.

4.3.3. The Final sample

The data from the initial 1150 schedules were scrutinized and 150 incomplete entries were ignored and only 1000 those found complete and correct in respect of all the necessary information required were chosen for analysis. Hence the final sample for the study was taken as thousand (1000) Upper Primary
school students. The break-up of the final sample in terms of Gender, Locale of Institution and Type of Management was estimated as given in Table 4.2

**TABLE: 4.2**  
*The break-up of the final sample in terms of Gender, Locale of Institution and Type of Management*

<table>
<thead>
<tr>
<th>Gender</th>
<th>Locality</th>
<th>Type of Management of school</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>Girls</td>
<td>Rural</td>
</tr>
<tr>
<td>482</td>
<td>518</td>
<td>540</td>
</tr>
<tr>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
</tbody>
</table>

The details given in the Table 4.2 indicate that, the final sample consists of 482 Boys and 518 Girls students of which 540 were from Rural setting and 460 from Urban setting. With respect to Type of Management of the school, 300 from Government schools, 350 from Aided schools and 350 from Unaided schools.

**4.4 TOOLS USED FOR THE STUDY**

For the present study, the investigator prepared two standardized Inventories, one for measuring the Multiple Intelligences and other for Science Interest of Upper Primary school students along with the General Information sheet. The following tools were used for the collection of data;

1. Multiple Intelligences Test Battery (MITB) for the Upper Primary School students (prepared and standardized by the Investigator).
2. Picturised Science Interest Inventory (PSII) for Upper Primary school students (prepared and standardized by the Investigator).
4.5 DESCRIPTION ON THE PREPARATION OF TOOLS

The details regarding the preparation and standardization of the tools were outlined below;

4.5.1 MULTIPLE INTELLIGENCES TEST BATTERY (MITB)

4.5.1.1 Preparation and Standardization of Multiple Intelligences Test Battery (MITB) for Upper Primary school students.

The prime objective of the study is to identify the Interrelationship among the components of Multiple Intelligences with Science interest on Upper Primary School students. Hence it was necessitated to construct a Test Battery that could measure all Intelligences and potentialities of a child and this should be on Primary school students. Taking these aspects in mind the investigator decided to prepare a Multiple Intelligences Test Battery (MITB) for students at Primary level based on the steps developed by Cronbach (1971).

The construction of Multiple Intelligences Test Battery (MITB) consists of mainly six phases. They were as follows;

Phase I – Defining Test purpose and Target group
Phase II – Developing Test plan and Composing Test items
Phase III – Conducting Pilot test and sample for Pre-test
Phase IV – Conducting Item analysis
Phase V – Revising the Final Test after Item Analysis
Phase VI – Validating the Test Battery

Phase I – Defining Test purpose and Target group

The investigator reviewed the literature and analyzed Multiple Intelligences Developmental Assessment Scale (1994) developed by Gardner and prepared a
MITB for the Upper Primary school students which were selected as sample. The details of the Multiple Intelligences Test Battery are given in Table 4.3

**TABLE 4.3**

*Purpose of the Multiple Intelligences Tests*

<table>
<thead>
<tr>
<th>Components of Multiple Intelligence</th>
<th>Selected domains of Multiple Intelligences</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Verbal- Linguistic Intelligence</td>
<td>1. Linguistic sensitivity</td>
</tr>
<tr>
<td></td>
<td>2. Reading</td>
</tr>
<tr>
<td></td>
<td>3. Writing</td>
</tr>
<tr>
<td></td>
<td>4. Speaking</td>
</tr>
<tr>
<td></td>
<td>1. Problem solving</td>
</tr>
<tr>
<td>2) Logical – Mathematical Intelligence</td>
<td>2. Calculations</td>
</tr>
<tr>
<td></td>
<td>3. Ability to perceive</td>
</tr>
<tr>
<td></td>
<td>1. Imagery</td>
</tr>
<tr>
<td>3) Spatial Intelligence</td>
<td>2. Artistic design</td>
</tr>
<tr>
<td></td>
<td>3. Construction</td>
</tr>
<tr>
<td>4) Bodily – Kinesthetic Intelligence</td>
<td>1. Physical skill</td>
</tr>
<tr>
<td></td>
<td>2. Dancing</td>
</tr>
<tr>
<td></td>
<td>3. Acting</td>
</tr>
<tr>
<td></td>
<td>4. Working with hands</td>
</tr>
<tr>
<td></td>
<td>1. Musical ability</td>
</tr>
<tr>
<td>5) Musical Intelligence</td>
<td>2. Instrument</td>
</tr>
<tr>
<td></td>
<td>3. Vocal</td>
</tr>
<tr>
<td></td>
<td>4. Appreciation</td>
</tr>
<tr>
<td>6) Inter-Personal Intelligence</td>
<td>1. Understanding people</td>
</tr>
<tr>
<td></td>
<td>2. Getting along with others</td>
</tr>
<tr>
<td></td>
<td>3. Leadership</td>
</tr>
<tr>
<td></td>
<td>1. Knowing myself</td>
</tr>
<tr>
<td>7) Intra- Personal Intelligence</td>
<td>2. Goal awareness</td>
</tr>
<tr>
<td></td>
<td>3. Managing feeling</td>
</tr>
<tr>
<td></td>
<td>4. Understanding Behaviour</td>
</tr>
<tr>
<td></td>
<td>1. Animal care</td>
</tr>
<tr>
<td>8) Naturalistic Intelligence</td>
<td>2. Plant care</td>
</tr>
<tr>
<td></td>
<td>3. Science loving</td>
</tr>
<tr>
<td></td>
<td>1. Ideas and ideals</td>
</tr>
<tr>
<td>9) Existential Intelligence</td>
<td>2. Questions on existence</td>
</tr>
<tr>
<td></td>
<td>1. Values –both social, moral spiritual values</td>
</tr>
<tr>
<td>10) Moral/ Spiritual Intelligence</td>
<td>2. Culture</td>
</tr>
</tbody>
</table>

The Test Battery was developed by the investigator by consulting the Experts in the field, covering almost all the factors and facets that govern various Intelligences of the child. This Test Battery was aimed for Upper Primary school.
students, but their psychological support was very strong and the questions were simple up to their mental level.

**Phase II – Developing Test plan and Composing Test items**

After consulting with experts in the field and Teacher educators, it was decided to use the technique developed by Likert. The selection of statements was done as follows.

The investigator reviewed various Psychological Books, Periodicals, other descriptive materials and owns school teaching experiences and knowledge helps to procure the material to construct the statements for the Intelligences Test Battery. It was decided to include 10 major components of Gardner’s Multiple Intelligences. These are categorized and plotted below;

1. Logical – Mathematical intelligence test
2. Linguistic intelligence test
3. Spatial intelligence test
4. Musical intelligence test
5. Bodily – Kinesthetic intelligence test
6. Inter personal intelligence test
7. Intra personal intelligence test
8. Naturalist intelligence test
9. Existential intelligence test
10. Moral/Spiritual intelligence test

An initial pool of 180 statements was prepared. These items were pooled randomly to form a preliminary list and submitted to ten experienced and qualified teachers and experts from educational experts. Before this the language was checked for ambiguity in wordings, if any. It was also ascertained that the vocabulary and the tendencies, usages used in the test item were usually shown by Upper Primary School students. The panels of experts were asked to evaluate the statements keeping in mind the following points:

1) Whether there were enough statements under each of the intelligence dimension.
2) Accuracy, clarity and relevance of each statement.  
3) The level of language and readability used for each statement.

Based on their suggestions, the statements, which are found complex, vague, over-generalized, and not appropriate to measure the behaviour were deleted. The remaining 160 statements formed the Draft form of the Multiple Intelligences Test Battery (MITB).

Out of the 160 statements 50 percent were of positive polarity and remaining 50 percent were of negative polarity (Best & Kahn, 2004; pp: 246-247). 16 statements each for every dimension of Intelligences were used to rate the respondent to the extent of their Multiple Intelligences. Each dimension or component of Intelligences was set as separate Inventories. For the convenience and ease the investigator gathered the whole components together in mixed form and made them as a single Questionnaire in which the items were randomly arranged. The tool consist of various inventories, hence it was named as Multiple Intelligences Test Battery (MITB). The Draft Test in Malayalam of MITB is given as Appendix-I.

**Phase III – Conducting Pilot test and Sample for Pre-test**

The 160 statements were arranged as in Likert type. To avoid any error or tendency to a stereotyped response, Items of positive polarity and negative polarity were evenly arranged. Directions for the respondents were also prepared. The students were asked to assign any one of the five categories after careful reading the statement. The five categories were:

A – Strongly Agree  
B – Agree  
C – Not Clear  
D – Disagree  
E – Strongly Disagree.

After the administration of the Test Battery, it was scored by keeping into consideration the scoring procedure suggested by Likert, (Edwards, 1957)
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For every positive polarity, the scoring system was as shown below:

A  response 5
B  response 4
C  response 3
D  response 2
E  response 1

For items of negative polarity, the scoring system was reversed.

For every A  response 1
B  response 2
C  response 3
D  response 4
E  response 5

Appropriate Response sheets were also prepared along with the Draft form of the Battery. The Draft test was administered to a sample of 400 Upper Primary school students randomly selected from various schools of Kollam district. The Test was administered for 1hour and 30 minutes. Proper instruction and directions were given before the test.

Freeman (1962) observes each test must be constructed by actually sampling the performance or responses of an adequate group that is typical of its population. So it was decided that the sample for the pre-test should be close representative of the final, which the test was intended so as to ensure generalization of test results. It was achieved by selecting a Proportionate Stratified sample as shown in Table 4.4

**TABLE 4.4**
The Standard wise and Sex wise classification of the Pre-test sample.

<table>
<thead>
<tr>
<th></th>
<th>Level of Education (Standard)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Boys</td>
<td>48</td>
</tr>
<tr>
<td>Girls</td>
<td>52</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
The Educational attainments of the various districts of Kerala were more or less the same. The investigator, therefore, decided upon selecting schools from the Kottarakkara Educational district with the practical considerations of Accessibility and Economy of time. The sample schools of the districts were, however chosen at Random for Draft test.

Phase IV – Conducting Item Analysis

The Draft scale was administered on a sample of (450) four hundred and fifty Upper Primary school students and responses were collected and scored. The sum of the scores questions was considered as score of corresponding component of Multiple Intelligences. The entries which were incomplete and ambiguous were rejected and finally 400 entries were taken for Item analysis.

The selection of Items for the final form of Multiple Intelligences Test Battery (MITB) was done as per the procedure suggested by Edwards (1957). The Response sheets of the individuals were arranged in the descending order of the scores of all components of Multiple Intelligence separately. The highest 25% and the lowest 25% of the Response sheets were separated \((N_H=25\) and \(N_L=25\)). These were criterion groups in terms of which to evaluate the individual statements for the corresponding Intelligences. In evaluating the responses of the high and low groups to the individual statements, the ratio was found out using the Edwards formula,

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

Where \(\overline{X}_H\) = the Mean score on a given statement for the high group.

\(\overline{X}_L\) = the Mean score on the same statement for the low group.

\(n\) = the Number of subjects in the upper and low groups.

\(X_H\) = score for a given statement in the high group.

\(X_L\) = score for a given statement in the low group.

The t-value for each item was calculated by using the same Formula for every components of Multiple Intelligence. The significant differences between
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higher group and lower group signifies the level t-value, and used for item analysis procedure. The statements for which t-value is greater than or equal to 1.75 was regarded as an item which possesses informal consistency and hence Discriminating Power (Edwards, 1957). Item analyses of the given statements in Multiple Intelligences Test Battery are given as Appendices-II to XI.

The investigator employed Item analysis for 10 components of Multiple Intelligences separately by using Edward’s formula. The Item selection from different components of Multiple Intelligences is done in such a way that, 14 Items were retained in all components of MI so as to make uniformity among the components of MITB. The descriptions of t-values are;

The investigator has selected those Items from Appendix II, having t-value between 1.75 and 6.2617 were selected for the final form of the Test Battery for measuring Verbal/Linguistic Intelligence. Those Items, having t-value greater than 6.2617 were discarded. Hence Item Nos. 66 and 71 were discarded from the final form.

The investigator has selected those Items from Appendix III, having t-value between 1.75 and 4.7081 were selected for the final form of the Test Battery for measuring Logical-Mathematical Intelligence. Those items, having t-value greater than 4.7081 were discarded. Hence Item Nos. 82 and 111 were discarded from the final form.

The investigator has selected those Items from Appendix IV, having t-value between 1.75 and 6.1630 were selected for the final form of the Test Battery for measuring Spatial Intelligence. Those items, having t-value greater than 6.1630 and less than 1.75 were discarded. Hence Item Nos. 103 and 127 were discarded from the final form.

The investigator has selected those Items from Appendix V, having t-value between 1.75 and 8.7302 were selected for the final form of the Test Battery for measuring Musical Intelligence. Those items, having t-value greater than 8.7302 were discarded. Hence Item Nos. 21 and 101 were discarded from the final form.

The investigator has selected those Items from Appendix VI, having t-value between 1.75 and 4.6538 were selected for the final form of the Test
Battery for measuring Naturalistic Intelligence. Those items, having t-value greater than 4.6538 were discarded. Hence Item Nos. 42 and 140 were discarded from the final form.

The investigator has selected those items from Appendix VII, having t-value between 1.75 and 4.9505 were selected for the final form of the Test Battery for measuring Bodily-Kinesthetic Intelligence. Those items, having t-value greater than 4.9505 were discarded. Hence Item Nos. 88 and 96 were discarded from the final form.

The investigator has selected those Items from Appendix VIII, having t-value between 1.75 and 6.2178 were selected for the final form of the Test Battery for measuring Interpersonal Intelligence. Those items, having t-value greater than 6.2178 were discarded. Hence Item Nos. 130 and 132 were discarded from the final form.

The investigator has selected those Items from Appendix IX, having t-value between 1.75 and 4.6192 were selected for the final form of the Test Battery for measuring Intrapersonal Intelligence. Those items, having t-value greater than 4.6192 were discarded. Hence Item Nos. 12 and 45 were discarded from the final form.

The investigator has selected those Items from Appendix X, having t-value between 1.75 and 5.3107 were selected for the final form of the Test Battery for measuring Existential Intelligence. Those items, having t-value greater than 5.3107 were discarded. Hence Item Nos. 142 and 152 were discarded from the final form.

The investigator has selected those Items from Appendix XI, having t-value between 1.75 and 6.1146 were selected for the final form of the Test Battery for measuring Moral/Spiritual Intelligence. Those items, having t-value greater than 6.1146 were discarded. Hence Item Nos. 15 and 24 were discarded from the final form.

Thus 14 statements were selected for each Inventory. Out of these 14 statements, 7 were of negative polarity and 7 were of positive polarity. Items with negative and positive polarity were distributed evenly in the decreasing order of
difference in Means. The 14 statements of ten components of Multiple Intelligences were evenly distributed and made into a single test battery.

**Phase V – Revising the Final Test after Item Analysis**

The final form of the Test Battery of Multiple Intelligences contained 140 statements and specific directions for the respondents. An appropriate Response sheet was prepared and printed along with the Questionnaire. The scoring procedure for the items of positive polarity is as follows;

- For every A - response 5
- B - response 4
- C - response 3
- D - response 2
- E - response 1

For the items of negative polarity the scoring procedure is as follows;

- For every A - response 1
- B - response 2
- C - response 3
- D - response 4
- E - response 5

The maximum and minimum scores, which the students may score on each component of Multiple Intelligences, were 70 and 14 respectively.

Investigator prepared General Information sheet to collect personal information about the sample along with the tool. It consists of details about the students such as Name, Sex, Age, Educational status, Type of school, Locality of home, School and Family Income.

The Multiple Intelligence Test Battery (MITB) for Upper Primary school students containing 140 items, 14 items for each component, with directions to the respondents were printed in a booklet and is given in Appendices. The Draft Test in Malayalam of MITB as Appendix-I, the Final Test in Malayalam of MITB as Appendix-XII and the Final Test in English of MITB as Appendix-XIII were given
as enclosures. The appropriate Response sheets were printed along with the Test Battery.

**Phase VI – Validating the Test Battery**

1) **Reliability of Multiple Intelligences Test Battery (MITB)**

   Anastasi (1959) considers the Reliability of a test as the consistency of the scores obtained by the same individuals on different occasions or with different sets of equivalent forms. The various definitions mentioned that Reliability stands for freedom from error of measurement.

**Methods for Estimating Reliability**

   To estimate the Reliability of the prepared MITB, we can use different methods. Some of the methods used for this are:

   1. Test-retest Method
   2. The parallel-form Method
   3. The Split-half Method
   4. Kuder – Richardson Formula
   5. Cronbach’s Alpha Formula

   Among these the investigator has selected Split-half Method and Cronbach’s Alpha Formula for estimating Reliability of the Test Battery. Each Intelligence Test was considered as separate tests for measuring Reliability of each components of Multiple Intelligence. Reliability co-efficient was separately measured by using Split-half Method and Cronbach’s Alpha Formula. For this, Components of Multiple Intelligences Test of 100 pupils selected from the total sample were taken.

A) **The Split-half Method**

   According to this method, each Intelligence Test was first divided into two equivalent halves; using by pooling the odd number of Items for one score and the even number of Items for the other. The score pairs for the two halves were used to calculate the Reliability co-efficient which is a co-efficient of interval consistency. The resulting co-efficient of correlation is a co-efficient of Reliability of one half of the test and must be adjusted (using Spearman-Brown Prophecy Formula) to be applicable to the whole test.
The Reliability was calculated by using Split half method and corrected by using Spearman-Brown Prophecy formula,

\[ R = \frac{nr_{1/2}}{1 + n_{1/2}} \]

Where,
- \( R \) = Reliability coefficient of the whole test
- \( n \) = Number of parts into which the test is divided
- \( r_{1/2} \) = Correlation coefficient of half test

For Split half Method,

\[ R = \frac{2r_{1/2}}{1 + n_{1/2}} \]

(Garrett, 2005, p339)

Where \( r_{1/2} \) is the Reliability coefficient of the half test

The Reliability coefficient obtained for each components of Multiple Intelligence (Split half method) is listed in Table 4.5

**TABLE 4.5**

*Reliability Coefficient of components of Multiple Intelligences (Split half Method).*

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Components of Multiple Intelligences</th>
<th>Reliability Coefficient, R</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Verbal/ Linguistic Intelligence</td>
<td>0.92</td>
</tr>
<tr>
<td>2.</td>
<td>Logical/Mathematical Intelligence</td>
<td>0.85</td>
</tr>
<tr>
<td>3.</td>
<td>Spatial Intelligence</td>
<td>0.94</td>
</tr>
<tr>
<td>4.</td>
<td>Bodily/ Kinesthetic Intelligence</td>
<td>0.91</td>
</tr>
<tr>
<td>5.</td>
<td>Musical Intelligence</td>
<td>0.88</td>
</tr>
<tr>
<td>6.</td>
<td>Interpersonal Intelligence</td>
<td>0.93</td>
</tr>
<tr>
<td>7.</td>
<td>Intrapersonal Intelligence</td>
<td>0.89</td>
</tr>
<tr>
<td>8.</td>
<td>Naturalistic Intelligence</td>
<td>0.90</td>
</tr>
<tr>
<td>9.</td>
<td>Existential Intelligence</td>
<td>0.84</td>
</tr>
<tr>
<td>10.</td>
<td>Moral/Spiritual Intelligence</td>
<td>0.91</td>
</tr>
</tbody>
</table>
B) Cronbach’s Alpha Formula

A better way to measure internal consistency is to compare individuals’ scores on all possible ways of splitting the test into two halves. This method compensates for any error introduced by a lack of equivalence in the two halves. Cronbach (1951) proposed a formula called co-efficient of Alpha, which calculates internal consistency for questions that have more than two possible responses. It was used to estimate internal consistency of a heterogeneous test, for measuring internal consistency. Cronbach’s Alpha co-efficient for each components of Multiple Intelligences is plotted in Table 4.6

TABLE 4.6

Reliability Coefficient of components of Multiple Intelligences (Cronbach’s Alpha Formula Method)

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Components of Multiple Intelligences</th>
<th>Reliability Coefficient, R</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Verbal/ Linguistic Intelligence</td>
<td>0.91</td>
</tr>
<tr>
<td>2.</td>
<td>Logical/Mathematical Intelligence</td>
<td>0.86</td>
</tr>
<tr>
<td>3.</td>
<td>Spatial Intelligence</td>
<td>0.94</td>
</tr>
<tr>
<td>4.</td>
<td>Bodily/ Kinesthetic Intelligence</td>
<td>0.90</td>
</tr>
<tr>
<td>5.</td>
<td>Musical Intelligence</td>
<td>0.86</td>
</tr>
<tr>
<td>6.</td>
<td>Interpersonal Intelligence</td>
<td>0.93</td>
</tr>
<tr>
<td>7.</td>
<td>Intrapersonal Intelligence</td>
<td>0.87</td>
</tr>
<tr>
<td>8.</td>
<td>Naturalistic Intelligence</td>
<td>0.91</td>
</tr>
<tr>
<td>9.</td>
<td>Existential Intelligence</td>
<td>0.83</td>
</tr>
<tr>
<td>10.</td>
<td>Moral/Spiritual Intelligence</td>
<td>0.91</td>
</tr>
</tbody>
</table>

C) Comparison of Split half co-efficient and Cronbach’s Alpha co-efficient

Comparison of two Reliability Coefficients is a better way to measure internal consistency to compare individuals’ scores on all possible ways of splitting the test into two halves. The consolidated scores of these two Reliability co-efficient provide us an insight on any error occurred by these two methods. The consolidated comparative chart is given in Table 4.7.
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TABLE 4.7

Consolidated Comparative chart of Reliability Coefficients of Components of Multiple Intelligences

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Components of Multiple Intelligences</th>
<th>Reliability Coefficient,R</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Split Half Method</td>
</tr>
<tr>
<td>1.</td>
<td>Verbal/ Linguistic Intelligence</td>
<td>0.92</td>
</tr>
<tr>
<td>2.</td>
<td>Logical/Mathematic Intelligence</td>
<td>0.85</td>
</tr>
<tr>
<td>3.</td>
<td>Spatial Intelligence</td>
<td>0.94</td>
</tr>
<tr>
<td>4.</td>
<td>Bodily/ Kinesthetic Intelligence</td>
<td>0.91</td>
</tr>
<tr>
<td>5.</td>
<td>Musical Intelligence</td>
<td>0.88</td>
</tr>
<tr>
<td>6.</td>
<td>Interpersonal Intelligence</td>
<td>0.93</td>
</tr>
<tr>
<td>7.</td>
<td>Intrapersonal Intelligence</td>
<td>0.89</td>
</tr>
<tr>
<td>8.</td>
<td>Naturalistic Intelligence</td>
<td>0.90</td>
</tr>
<tr>
<td>9.</td>
<td>Existential Intelligence</td>
<td>0.84</td>
</tr>
<tr>
<td>10.</td>
<td>Moral/Spiritual Intelligence</td>
<td>0.91</td>
</tr>
</tbody>
</table>

These values show that Reliability Co-efficient obtained from both Split Half Method and Cronbach’ Alpha Formula Method were comparative for each Components of Multiple Intelligence and Reliability Co-efficient for the Components of Multiple Intelligences in MITB was very high.

2) Validity of Multiple Intelligences Test Battery (MITB)

The Validity of a test was defined by Bingham as (1942) “is the closeness of agreement between the scores and some other objective measure of that which
the test is used to measure”. Validity depends on the efficiency with which it measures what it attempts to measure.

Garrett (1977) observes that the ‘validity of a test or measuring instrument depends upon the fidelity with which it measures what it purports to measure’.

**Different types of Validity**

The concept of Validity, as its definition implies is a relative characteristic, it is not absolute, Garrett states “validity is a relative term. A test is valid for a particular situation – it is not generally valid”.

**Validating the present Test Battery**

Evidence regarding the Validity of the present Test Battery lies partly in the procedures taken in developing the test and partly in the Validity studies conducted after test development was described below.

The Content Validity and Face Validity of the Test have been established by referring the series of systematic steps in construction of the Multiple Intelligences Test Battery (MITB) with the Experts in the fields namely the Professors in Psychology, the Professors of the colleges of Education and school teachers. The Construct validation was ensured through meticulous planning of the Test and satisfying the adequacy of sampling of Test Items by following the standard theoretical models of the construction to be measured. The tool, MITB, was subjected for 25 Experts in the field for Validation. They extended maximum co-operation and marked the items in the tool by recognizing the common characteristics of Intelligentsia of students. They were requested to put a score out off 10 for the Multiple Intelligences Test Battery (MITB). It is included in Appendix XIV.

94 % of Experts’ suggested that the Test battery was very good. 5 % of Experts opined as good. Only 1 % of Experts were opposed that this tool was average at Upper Primary secondary level. The tool was Valid up to 94 % and it
has good Construct Validity. It’s a good tool for measuring the Intelligentsia of Upper Primary school students. The Experts’ selected for Validation were the Reputed Teachers, Psychologists and Eminent Educationists in the field of Research.

The high Validity and Reliability coefficients, thus obtained show that the Test Battery was a reasonably valid and Reliable.

**4.5.1.2. Consolidated form of Items selected for Final Test of MITB**

The following numbered Items were taken for final test of MITB

<table>
<thead>
<tr>
<th>Components of Multiple Intelligence</th>
<th>Item Nos. selected for Final Test Battery</th>
<th>Item Nos. deleted from the Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linguistic intelligence</td>
<td>1,7,17,46,51,53,59,77,90,91,107,120,123,137</td>
<td>66,71</td>
</tr>
<tr>
<td>Logical/ Mathematical Intelligence</td>
<td>2,8,18,31,32,39,47,54,70,72,89,110,116,131</td>
<td>82,111</td>
</tr>
<tr>
<td>Naturalistic intelligence</td>
<td>5,10,22,23,36,37,44,50,73,85,106,129,138,139</td>
<td>42,140</td>
</tr>
<tr>
<td>Interpersonal intelligence</td>
<td>6,13,29,38,48,64,80,87,115,118,122,125,126,128</td>
<td>130,132</td>
</tr>
<tr>
<td>Intrapersonal intelligence</td>
<td>14,30,40,52,58,65,75,76,81,86,93,97,112,114</td>
<td>12,45</td>
</tr>
<tr>
<td>Bodily/ Kinesthetic</td>
<td>9,20,34,43,56,61,63,68,74,79,99,102,121,134</td>
<td>88,96</td>
</tr>
<tr>
<td>Existential Intelligence</td>
<td>16,27,105,133,144,146,148,150,154,156,157,158,159,160</td>
<td>142,152</td>
</tr>
<tr>
<td>Moral/Spiritual Intelligence</td>
<td>25,26,28,41,95,124,141,143,145,147,149,151,153,155</td>
<td>15,24</td>
</tr>
</tbody>
</table>
4.5.2 PICTURISED SCIENCE INTEREST INVENTORY (PSII)

4.5.2.1 Preparation and Standardization of Picturised Science Interest Inventory (PSII) for Upper Primary school students.

The critical role of teaching involves assessing students’ abilities and planning instruction accordingly. However, the focus of such assessments is often limited to Teacher domination and overhaul students’ abilities and tastes accordingly. The likes and dislikes of students were ignored by the Teacher. Hence the investigator desired to prepare an Interest Inventory particularly related to Science and assessing Science Interest (Picturised form) that has entrenched in students taken as an innovative model (PSII) by keeping Picturised Interest Inventory by Wilbourn and Alley (1978) and Chatterji’s Non-language Preference Record (1982) as role models.

4.5.2.2 Construction of Picturised Science Interest Inventory (PSII)

The prime objective of the study was to identify the Science Interest of Elementary school students. The construction of Picturised Science Interest Inventory (PSII) consists of mainly seven phases. They are as follows;

- Phase I - Planning and Development of Test Items
- Phase II - Developing Test plan and Composing Test items
- Phase III - Selection of the sample for Pilot Test
- Phase IV - Administration of the Pilot Test
- Phase V - Conducting Item Analysis
- Phase VI - Revising the Final Test after Item Analysis
- Phase VII - Validity and Reliability of the Inventory

Phase I – Planning and Development of Test Items

The development of a psychological test pre-supposes knowledge of the variable to be measured. This, in other words, means that the test construction has made an operational analysis of the psychological construct in question. Certain important Interest Inventories are also studied by the Investigator with special
reference to the content, selection of Items and the procedures used for the Validity and Reliability of the Tools.

The investigator observes that there is no sufficient tool to measure Science Interest of Upper Primary School students. Hence the Investigator prepared a Picturised Tool to measure Science Interest. For the preparation of the tool the investigator referred various Interest Inventories like Kuder Inventory (1957), Strong’s Inventory (1927) and Kerala University Science Interest Inventory by Thomas (1971) was Verbal and Chatterji’s Non-language Preference Record (1982) was Non-verbal.

The investigator had in mind an economic tool of the Non-language type and hence the third Inventory was more used for deciding the construction techniques of test development procedures. The Picturised Science Interest Inventory (PSII) was taken as innovative model based on Picturised Interest Inventory of Wilbourn and Alley (1978).

Thus, the investigator decided to develop a Picturised Science Interest Inventory (PSII). For this, a pictorial representation test was decided to prepare. Pictures were collected from various sources including Internet, Newspapers etc. Then they were homogeneously arranged. Questions were framed for each Item and arranged in homogeneous manner. The process of evolving good test item was rather difficult. The abilities needed too deeply rooted and too slow of growth to be produced in a short period of time. The item type decided upon contained four generally interesting alternatives, out of which one indicated an unmistakable interest in Science, while the remaining three were distracters, clearly indicated interest in areas outside Science.
The following example would illustrate this Item type;

In this, which arrangement would you like most?

(a)    (b)    (c)    (d)

In the above item, choice two (b) is clearly indicative of Science Interest while choice one (a), three (c) and four (d) were clearly not indicative of Science Interest, which may act as distracters. It was decided to use this type of Items for the present Inventory.

**Phase II – Developing Test plan and Composing Test Items**

In the process of standardizing a test, it was administered to a large, representative sample of the type of persons for whom it is designed. Test construction authorities were in favour of the view that the time allotment of a Test should be such that the pupils should get time sufficient enough to complete all the Items in it.

Ross (1962) suggests that in the Try out, sufficient time be allowed so that all or practically all, the pupils have time to finish all the items.

The Draft test consists of Picturised Items to determine the Science Interest of Primary School Students.

The Draft test of 60 Items was prepared. Every care was taken to see that the items contained activities which are of Interest to students of Primary Schools. Activities which are not practicable under Indian conditions were excluded. Care was also taken to see that the alternative appeared to be of equal level of attraction or chance to the students. In preparing items sampling of Science Interest, a broad range of activities were included to make the Test sample effectively a wide variety of situations. The Draft test is given as Appendix-XV.
Phase III – Selection of the Sample for Pilot Test

Good (1945) defined a sample as “A finite number of observations or cases selected from all cases in a particular universe often assumed to be representative of the total group of universe of which it is a part”.

Conrad (1969) states that the Test constructor should try out not only to obtain representative samples in order to avoid bias in his data but he should also try to obtain samples that are ‘efficient’ in the sense that they yield maximum information about the population per individual tested.

So it was decided that the sample for which the pre-test should be close representative of which the test was intended so as to ensure generalization of test results. It was achieved by selecting a Proportionate Stratified sample as shown in Table 4.8.

**TABLE 4.8**

*The Standard wise and Sex wise classification of the Pre-test Sample.*

<table>
<thead>
<tr>
<th>Sex</th>
<th>Level of Education (Standard)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V</td>
<td>VI</td>
</tr>
<tr>
<td>Boys</td>
<td>46</td>
<td>62</td>
</tr>
<tr>
<td>Girls</td>
<td>54</td>
<td>58</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>120</td>
</tr>
</tbody>
</table>

The Educational attainments, of the various districts of Kerala are more or less the same. The investigator, therefore, decided upon selecting schools from the Kottarakkara Educational district with the practical considerations of Accessibility and Economy of time. The sample schools of the districts were, however chosen at random. The sample selected for pre-test was a representation of the whole population.
Phase IV – Administration of the Pilot Test

(a) Preliminary consideration:-

Once the schools and the size of the sample were decided upon, the next step was the actual administration of the Test to the selected sample of pupils. The tests should be administrated under ideal conditions. All the steps should be carefully planned from the beginning to the end. The first step was to contact the school Authorities for granting permission for administering the Test for the Primary School students of standard V, VI & VII and the final step was the Collection, Tabulation and Consolidation of the Test data.

(b) Procedure in administering the tests:-

The investigator strictly followed the directions regarding the administration of the Test implicitly.

The test booklets were distributed, when all the students were comfortably seated. They were strictly told not to open the booklets until they were asked to do so. When the distribution of papers was complete, the testees were given oral instructions to answer the questions. They were specifically directed not to mark on any part of the booklet other than the specified part in it.

(c) Administering the General Data sheet:-

After the completion of the test, the General Information sheet was given. Precautions were taken to ensure that only reliable and accurate data were entered. The information that was available from the school cumulative records including the Terminal marks was recorded by the investigator.

Phase V -- Conducting Item Analysis

Each of correct answer regarding to Science Interest was given one mark. The marks were added and entered at the top of the response sheet.

Item Analysis of Draft Test:-

There are different methods to finding Item Analysis. Of these the easiest and simplest Method is Kelley’s Method (1939). So this method was used for the Item Analysis of the present study. A sample of 370 Upper Primary School students was taken for the pilot test. According to this method the highest 27% and
lowest 27% of students from the total score obtained for the Picturised Science Interest Inventory (PSII) were taken, after scoring the papers and arranging them in ascending or descending order. Then, from this, Difficulty Index and Discriminating Power were calculated by using the formula.

\[
\text{Difficulty index} = \frac{U + L}{2N} \\
\text{Discriminating power} = \frac{U - L}{N} 
\]  
  (Garrette, 1977)

The details of values calculated for Difficulty Index and Discriminating Power are given in Appendix No: XVI

**Criteria for Selection of Items**

It was seen that most of the Items were discriminated between the two extreme groups. However, it was decided to select the best discriminating Items. It was suggested that Items with Difficulty Index value between 0.500 and 0.735 and Discriminating Power above 0.35 were selected as good Items. Thus Item Numbers 14, 15, 18, 22, 35, 41, 45, 50, 52 and 54 were discarded. Accordingly 50 (fifty) Items were selected for the Final Test.

**Phase VI – Revising the Final Test after Item Analysis**

The Final Test consist of 50 Items was prepared. Suitable instructions were given at the beginning. The Final Test is given as Appendix-XVII (Malayalam). An English version of the Test is given as Appendix-XVIII. A slightly modified form was adopted for the Draft for entering answers. A separate Score sheet for PSII was developed. This is given as Appendix-XIX.

A Super imposing the Windowed Scoring key was prepared by the investigator and all the answer sheets were manually scored. The Score Key is given as Appendix- XX.

**Phase VII – Validity and Reliability of the Inventory**

Validity and Reliability are the two essential characteristics of a sound test. In Micheels and Karnes’s (1950) opinion, a good test must actually measure what it is supposed to measure (Validity) and it must do this accurately and consistently
(Reliability). A Test may be Reliable without being valid but it cannot be valid without being reliable.

**Validity of the Picturised Science Interest Inventory (PSII)**

Evidence regarding the Validity of the present Test lies partly in the procedures taken in developing the Test and partly in the validity studies conducted after test development is described below.

1. **Validity of the Inventory using Teacher Ratings as External Criteria**

A group of 50 students for Standard VI of Govt. UPS Punalur, were used for the present study. The list of names of those selected 50 students were prepared and given to the Teachers, who teach science in those classes. These Teachers were asked to rate their students according to the Interest in Science on a Five-point scale.

The following descriptions were given for the scale.

|-------------------------------|----------------------------------|-----------------------------|-----------------------------------|-------------------------------|

The Teachers were asked to tick in one of the squares to indicate the level of Science Interest of each of the students in the class. No specific direction was given as to how to appraise Science Interest. However the teacher was asked to observe the student carefully for a period of 3 weeks with a view to understand his Interest in Science. After the prescribed period, the teachers gave their ratings for 50 students. Since the students had been given the Science Interest Inventory earlier, the scores on their test were correlated with the Teacher Ratings. The Teacher Ratings were converted into Scores. The lowest Rating received a Score of 1 (one) and the highest Rating received was 5 (five). Teacher Rating scores and Test scores is given in Table 4.9.
From the Teacher Rating scores and Test scores, a Scatter Diagram was formed. The Scatter Diagram is shown in Table 4.10.

The correlation between Teacher Ratings and Science Interest scores of students were computed by calculating the Rank Difference Co-efficient.

**TABLE 4.9**

*Teacher Ratings and Science Interest scores of 50 students*

<table>
<thead>
<tr>
<th>No</th>
<th>Teacher Ratings</th>
<th>Score Obtained by the student</th>
<th>No</th>
<th>Teacher Ratings</th>
<th>Score Obtained by the student</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>31</td>
<td>26</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>43</td>
<td>27</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>20</td>
<td>28</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>25</td>
<td>29</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>21</td>
<td>30</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>20</td>
<td>31</td>
<td>4</td>
<td>40</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>13</td>
<td>32</td>
<td>3</td>
<td>22</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>48</td>
<td>33</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>16</td>
<td>34</td>
<td>3</td>
<td>21</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>25</td>
<td>35</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>11</td>
<td>3</td>
<td>19</td>
<td>36</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
<td>38</td>
<td>37</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>41</td>
<td>38</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>14</td>
<td>3</td>
<td>18</td>
<td>39</td>
<td>4</td>
<td>36</td>
</tr>
<tr>
<td>15</td>
<td>4</td>
<td>21</td>
<td>40</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>16</td>
<td>3</td>
<td>16</td>
<td>41</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>17</td>
<td>3</td>
<td>31</td>
<td>42</td>
<td>3</td>
<td>27</td>
</tr>
<tr>
<td>18</td>
<td>2</td>
<td>15</td>
<td>43</td>
<td>3</td>
<td>40</td>
</tr>
<tr>
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<td>5</td>
<td>44</td>
<td>44</td>
<td>4</td>
<td>41</td>
</tr>
<tr>
<td>20</td>
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<td>15</td>
<td>45</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>21</td>
<td>3</td>
<td>45</td>
<td>46</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>22</td>
<td>4</td>
<td>46</td>
<td>47</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>23</td>
<td>3</td>
<td>31</td>
<td>48</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>24</td>
<td>2</td>
<td>18</td>
<td>49</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>25</td>
<td>1</td>
<td>13</td>
<td>50</td>
<td>5</td>
<td>48</td>
</tr>
</tbody>
</table>
TABLE 4.10

*Scatter Diagram between Test score Vs Teaching Rating*

<table>
<thead>
<tr>
<th>Teacher rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>X Y</td>
</tr>
<tr>
<td>5 5</td>
</tr>
<tr>
<td>4 4</td>
</tr>
<tr>
<td>3 3</td>
</tr>
<tr>
<td>2 2</td>
</tr>
<tr>
<td>1 1</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>5 11 19 5 3 2 7 3 50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test score →</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-9 10-15 16-21 22-27 28-33 34-39 40-45 46-51 Total</td>
</tr>
<tr>
<td>1 2 3 1 7 3 1 7 17</td>
</tr>
<tr>
<td>8 3 3 3 3 17</td>
</tr>
<tr>
<td>8 7 2</td>
</tr>
<tr>
<td>0 11 19 5 3 2 7 3 50</td>
</tr>
</tbody>
</table>

\[
r = \frac{N\Sigma f_x \times f_y - \Sigma f_x \times \Sigma f_y}{\sqrt{[N\Sigma (f_x)^2 - (\Sigma f_x)^2][N\Sigma (f_y)^2 - (\Sigma f_y)^2]}}
\]

\[
r = \frac{50 \times 63 - (-16 \times 49)}{\sqrt{[50 \times 239 - (49)^2][50 \times 60 - (-16)^2]}}
\]

\[
r = 0.8909
\]

Validity Co-efficient = 0.8909

The obtained Validity Co-efficient was 0.8909. The Co-efficient shows that there was a good degree of agreement between the two types of measurement. The obtained Co-efficient indicates that the Inventory was highly valid.
Reliability of the Picturised Science Interest Inventory (PSII)

Anastasi (1959) considers the Reliability of a test as the consistency of the scores obtained by the same individuals on different occasions or with different sets of equivalent forms. The various definitions mentioned that Reliability stands for freedom from error of measurement.

Methods for Estimating Reliability

To estimate the Reliability of the prepared Interest Inventory, we can use different methods. Some of the methods used for this are;

1. Test-retest Method
2. The parallel-form Method
3. The Split-half Method
4. Kuder – Richardson 20 Formula

Among these the investigator selected Split-half Method and Kuder- Richardson 20 Formula. Marks of 100 pupils selected from the total population.

A) The Split-half Method

According to this method the Test is first divided into two equivalent halves; using by pooling the odd number of Items for one score and the even number of items for the other. The score pairs for the two halves were used to calculate the Reliability co-efficient which is a co-efficient of interval consistency. The resulting co-efficient of correlation is a co-efficient of Reliability of one half of the Test and must be adjusted (using Spearman-Brown Prophecy Formula) to be applicable to the whole Test.

Correlation of 100 pupils half scores are given in Table 4.11
## Methodology

### TABLE 4.11

**Scatter Diagram between Scores on Odd Items Vs Scores on Even Items**

<table>
<thead>
<tr>
<th></th>
<th>0-3</th>
<th>4-7</th>
<th>8-11</th>
<th>12-15</th>
<th>16-19</th>
<th>20-23</th>
<th>24-27</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>20-23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>15</td>
<td>6</td>
<td>23</td>
</tr>
<tr>
<td>16-19</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>5</td>
<td>11</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>12-15</td>
<td></td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td></td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>8-11</td>
<td>6</td>
<td>16</td>
<td>5</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>28</td>
</tr>
<tr>
<td>4-7</td>
<td>2</td>
<td>7</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>0-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>11</td>
<td>26</td>
<td>14</td>
<td>12</td>
<td>30</td>
<td>7</td>
<td>100</td>
</tr>
</tbody>
</table>

\[
\begin{align*}
\frac{r_{1/2}}{2} &= \frac{N\sum f_x x^1 \times f_y y^1 - \Sigma f_x x^1 \times \Sigma f_y y^1}{\sqrt{[N\sum (f_x x^1)^2 - (\Sigma f_x x^1)^2][N\sum (f_y y^1)^2 - (\Sigma f_y y^1)^2]}} \\
&= \frac{100 \times 380 - (145 \times 126)}{\sqrt{[100 \times 455 - (145)^2][100 \times 382 - (126)^2]}} \\
\frac{r_{1/2}}{2} &= 0.8441
\end{align*}
\]

Since this is the correlation of half the test, the reliability of the whole test was found out by using the formula.

\[
R = \frac{2_{r1/2,1/2}}{1 + 2_{r1/2,1/2}}
\]

\[
= \frac{2 \times 0.8441}{1 + 0.8441}
\]

\[
= 0.9155
\]

**Reliability of the Inventory** = **0.9155**
B) **Kuder – Richardson-20 Formula**

\[
r_{tt} = \frac{n}{n-1} \left[ \frac{\sigma^2 - \Sigma pq}{\sigma^2} \right]
\]

\[
\Sigma pq = 11.75, \quad n = 50, \quad \sigma = 11.86
\]

\[
\sigma^2 = 140.66
\]

\[
r_{tt} = \frac{50}{50-1} \left[ \frac{140.66 - 11.75}{140.66} \right]
\]

\[
= 0.9352
\]

Reliability of the Inventory = **0.9352**

The resulting Reliability Co-efficient of PSII obtained through Split half Method (0.9155) and Kuder – Richardson-20 (0.9352). This indicates the fact that the present PSI Inventory was highly reliable measure for estimating Science Interest of Upper Primary school students.

**4.5.3 Other Tool Used**

The other tool used was General Information Sheet, both in Malayalam and English, enclosed as Appendix-XXI for collecting the details regarding Name, Class, Gender, Locale, Educational qualification of parents, Monthly Income and Type of school from the students. This tool supplements the Major Objectives of the study.

**4.6 PROCEDURE FOR DATA COLLECTION AND FINAL TESTING**

Once the schools and the size of the sample were decided upon, the next step was the actual administration of the tests to the selected sample of pupils. The tests should be administrated under ideal conditions. All the steps should be carefully planned from the beginning to the end. After making necessary arrangements for the collection of data the investigator visited the selected schools and obtained permissions from the Head of the institutions. Before
answering the Multiple Intelligences Test Battery (MITB) and Picturised Science Interest Inventory (PSII), clear and precise instructions were given to prevent any sort of confusions on the part of the respondents. On the whole 1150 schedules were administered; the students answered the schedule in the presence of the investigator and cleared their doubts. The data thus obtained were scrutinized and 150 incomplete entries were ignored and only 1000 those found complete and correct in respect of all the necessary information’s required were chosen for Analysis.

Two Consecutive periods were taken for the completion of MITB and PSII and that was fixed in the morning periods so as to avoid the fatigue effect. Students were given clear instruction as to how to proceed and respond. The test booklets were distributed, when all the students were comfortably seated. They were strictly told not to open the booklets until they were asked to do so.

The population of the study consisted of 1000 Upper Primary school students of Kerala following State syllabus. The investigator adopted Simple Random sampling technique for the sample selection. The sample was particularly collected from Government, Aided and Unaided schools of Rural and Urban areas. 30 divisions of Standard V, VI & VII students of twenty five schools from two districts of Kerala (Kollam & Trivandrum) were selected for the study. List of schools are Appendices as No: XXII.

After the completion of the test, the General Information sheet was given. Precautions were taken to ensure that only reliable and accurate data were entered. The information that was available from the school Records including the terminal marks was recorded by the investigator.

Subsequently the investigator entered in to the final step collection, tabulation and consolidation and brings the data under suitable statistical techniques.
4.7. STATISTICAL TECHNIQUES USED

The data collected were analysed by using appropriate Statistical Techniques. The major Statistical Techniques used in the present study were classified into three main heads according to their purpose.

They were;

1. For Item Analysis.
2. For estimating Validity and Reliability.
3. For Data Analysis and interpretation.

A) For Item Analysis:-

For the present study the investigator used two methods of Statistics for Item Analysis.

1. Edward’s Formula – for calculating t-value of a Five pointed Likert’ scale.
2. Kelley’s Method - for calculating Difficulty Index and Discriminating Power.

B) For Estimating Validity and Reliability:-

In this study the Investigator used three methods Statistics for Validation.

1. Split half Method
2. Cronbach’s Alpha Formula
3. Kuder-Richardson 20 Formula

C) For Data Analysis and Interpretation:-

In this study the investigator used various methods for Data Analysis and Interpretation. They are described below;

4.7.1 Arithmetic Mean ($\bar{X}$)

$$\text{Mean } \bar{X} = \frac{\Sigma x}{N}$$

$\Sigma x$ = the sum of scores of all students

$N$ = Total number of students
4.7.2 Standard Deviation ($\sigma$)

It measures absolute dispersion or variability of the Description. The greater amount of variability greater the Standard Deviation. It reveals high degree at uniformity of observation.

\[ \sigma = \frac{1}{N} \sqrt{\sum(X^2) - \left(\frac{\sum X}{N}\right)^2} \]

$\sigma$ = Standard Deviation  
$X$ = Observed values  
$N$ = Number of Items

4.7.3 Test of Significance of the Means:

The procedure is to work out the t-values (Critical Ratio) given by the formula,

\[ \text{C.R.} = \frac{M_1 - M_2}{\sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}} \]

Where,

$M_1$ = Mean test score of the first group  
$M_2$ = Mean test score of the second group  
$\sigma_1^2$ = Standard deviation of the first group  
$\sigma_2^2$ = Standard deviation of the second group  
$N_1$ = Size of the first group  
$N_2$ = Size of the second group

4.7.4 Test of significance of the Correlation co-efficient

\[ \text{C.R.} = \frac{r\sqrt{N-2}}{\sqrt{1-r^2}} \]
Where,

\[
\begin{align*}
\text{C.R.} & = \text{Critical Ratio} \\
r & = \text{Correlation Co-efficient} \\
N & = \text{Sample size} \\
N-2 & = \text{Degrees of Freedom.} \quad (\text{Garrett, 2005})
\end{align*}
\]

### 4.7.5 Product Moment Co-efficient of correlation and Critical Ratio

Product moment coefficient of correlation between two variables \(x\) and \(y\) when they are given as ungrouped pairs was calculated by the formula

\[
r' = \frac{N \sum XY - \sum X \sum Y}{\sqrt{N \sum X^2 - (\sum X)^2} \sqrt{N \sum Y^2 - (\sum Y)^2}}
\]

Where;

\[
\begin{align*}
r & = \text{Correlation Co-efficient} \\
N & = \text{No. of students} \\
\Sigma X & = \text{Sum of X Scores} \\
\Sigma Y & = \text{Sum of Y Scores} \\
\Sigma X^2 & = \text{Sum of Squares of X Scores} \\
\Sigma Y^2 & = \text{Sum of Squares of Y Scores} \\
\Sigma XY & = \text{Sum of product of X and Y} \\
N_1 & = \text{Size of first sample} \\
N_2 & = \text{Size of second sample}
\end{align*}
\]

The Interpretation of ‘\(r\)’ in terms of verbal description is as follows

(Garrett, 1969).

1. \(r\) from 0.00 to ± 0.20 denotes indifference or Negligible relationship
2. \(r\) from ± 0.20 to ± 0.40 denotes Low correlation present but slight
3. \(r\) from ± 0.40 to ± 0.70 denotes Substantial or Marked relationship
4. \(r\) from ± 0.70 to ± 1.00 High or Very high relationship
Methodology

\[ C.R. = \frac{z_1 - z_2}{\sqrt{\frac{1}{N_1 - 3} + \frac{1}{N_2 - 3}}} \]

Where \( z_1 \) is Fisher’s \( z \)-value for \( r_1 \); \( z_2 \) is Fisher’s \( z \)-value for \( r_2 \)

### 4.7.5.1 Coefficient of Partial Correlation (r) (SPSS output)

1. \[ r_{12.345} = \frac{r_{12.34} - r_{15.34}r_{25.34}}{\sqrt{(1 - r_{15.34}^2)(1 - r_{25.34}^2)}} \]

2. \[ r_{13.452} = \frac{r_{13.45} - r_{14.45}r_{24.45}}{\sqrt{(1 - r_{14.45}^2)(1 - r_{24.45}^2)}} \]

3. \[ r_{14.523} = \frac{r_{14.52} - r_{13.52}r_{23.52}}{\sqrt{(1 - r_{13.52}^2)(1 - r_{23.52}^2)}} \]

4. \[ r_{15.234} = \frac{r_{15.23} - r_{14.23}r_{23.24}}{\sqrt{(1 - r_{14.23}^2)(1 - r_{23.24}^2)}} \]

### Significance of ‘r’s

The obtained correlations were interpreted using test of significance of ‘r’s against the null hypothesis (r=0). The procedure used for this is as follows:

Each obtained ‘r’ was compared with the value \( 1 \times \frac{2.58}{\sqrt{N}} \) for 0.01 levels of significance.

### 4.7.5.2 Significance of Partial correlation ‘r’ can be tested by using the ‘t’ distribution

\[ t = \frac{r\sqrt{N - 2 - K}}{\sqrt{1 - r^2}} \]

Where,

- \( r \) = Value of Partial correlation
- \( K \) = Order of Partial ‘r’
- \( N \) = Total frequencies in the sample study

Therefore,

Degree of freedom = \( N - 2 - K \)
4.7.5.3 Coefficient of Multiple Correlation (R) (SPSS output)

\[ R_{1,2345...} = \sqrt{r_{12}^2 + r_{13}^2 + r_{14}^2 + r_{15}^2 \ldots - 2r_{12}r_{13} + r_{14} \ldots r_{2345\ldots}} \frac{1}{1 - r_{2345..}^2} \]

\( R_{1,2345...} \) denotes the coefficient of correlation between the dependent variable Science Interest and the combination of independent variables of ten Components of Multiple Intelligences.

4.7.5.4 Significance of Multiple Correlation coefficients

The significance of multiple correlations R can be tested with the help of its standard error.

\[ SE_r = \frac{1 - R^2}{\sqrt{N - m}} \]

Where,

- \( SE_r \) = Standard error of multiple correlation R
- \( m \) = Number of variables being correlated
- \( N \) = Size of the sample
- \( N-m \) = Degrees of freedom

4.7.6 One way ANOVA

The Data with respect to the comparison of Multiple intelligences of students at various Educational levels and Achievement in Science, Science Interest of students at various Educational levels and Achievement in Science, Interrelationship between Multiple Intelligences and Science Interest with regard to various educational Levels and Achievement in science are developed using the ANOVA test. Using Critical Difference, the Means are compared. This \( F \)-test enables as to determine whether the sample Means differ from one another (Between Group Variance) to a greater external then the test scores different from their own sample Means (Within Group Variance) using the ratio:

\[ F-Value = \frac{\text{Variance between Groups}}{\text{Variance within Groups}} \]
4.7.7 Multiple/Post Hoc Group Comparisons in ANOVA (SPSS output)

In one-way ANOVA (F-statistic tests) whether the treatment effects are all equal, (i.e. that there are no differences among the means of the k groups), a significant F-value indicates that there are differences in the means, but it does not tell where those differences are and how much it is? E.g: Group 1’s mean might be different than Group 2’s mean, but not different from Group 3’s mean. To isolate where the differences are, it could do a series of pairwise t-tests. The problem with this is that the significance levels can be misleading. For example, if there are 7 groups, there will be 21 pairwise comparisons of means; if using the 0.05 level of significance, it would expect at least one statistically significant difference even if no differences exist (type I error). Therefore, various methods have been developed for doing multiple comparisons of group Means. Hence Post Hoc group comparison tests compare the means of the treatment groups two at a time (pair wise) to assess where a significant mean difference exists.

4.7.8 Scheffe’s Multiple Comparison test (Ferguson, 1976)

Scheffe’s test is used as a Post Hoc comparison between the pairs of different levels of independent variables, if the main effect of an independent variable on a dependent variable is significant. The procedure of Scheffe’s test is as follows.

**Step I.** Calculate F-ratio between the pairs of means by using the within group variance estimated.

**Step II.** Consult a table of F and obtain the value F required for significance at 0.05 level for Degrees of Freedom, df₁ = k-1, and df₂ = N-k.

**Step III.** Calculate F*, where $F^* = (k-1) F$

**Step IV.** Compare the values of F and F*.

For any difference to be significant at the required level, F must be greater than or equal to F*.

Scheffe’s $F^*$ value = $LSD^2 / (k – 1)$. 

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Where,

\( k \) = Number of Groups

\( N \) = Total Number of observations

\[
LSD_{i-j} = \frac{\hat{\mu}_i - \hat{\mu}_j}{s_{\hat{\mu}_i - \hat{\mu}_j}}
\]

\[
s_{\hat{\mu}_i - \hat{\mu}_j} = \sqrt{\frac{MSE}{N_i} \left( \frac{1}{N_i} + \frac{1}{N_j} \right)}
\]

MSE = Mean sum of squares within groups

\( N_i \) = Number of observations in \( i^{th} \) group

\( N_j \) = Number of observations in \( j^{th} \) group

For each pair Scheffe’s test can be calculated by using the above formula. The value thus obtained is significant at 0.05 levels, if it is greater than the Table value of F with respect to the df \((k-1, N-k)\). This Scheffe’s Post Hoc test is known to be conservative, which helps to compensate for spurious significant results that occur with multiple comparisons. The test gives a measure of the difference between all means for all combinations of Means.

4.7.9 Multiple Linear Regression (Entry Method) and Beta Co-efficient (SPSS Output)

It illustrates the overall relationship between the two variables. The equation of regression is as follows

\[
\bar{y} = r \frac{\bar{y}}{\bar{x}} \times x
\]

(Regression equation of \( y \) on \( x \), deviations taken from the means of \( y \) and \( x \))

The factor \( r \frac{\bar{y}}{\bar{x}} \) is called Regression Co-efficient and is often replaced by the terms \( b_{yx} \) or \( b_{12} \), so that formula may be written \( \bar{y} = b_{yx} \times x \) or \( \bar{y} = b_{12} \times x \). (\( y \) means that our estimate is an average value).
\[ \bar{y} = r \frac{\bar{x} - \bar{x}}{\sigma_x} \] gives the relationship between y and x in deviation form; it can be used only when y is to be predicted from a given x (when y is the dependent variable).

The regression equation which expresses the relationship between a single variable, \( X_1 \), and any number of independent variables, \( X_2, X_3, X_4, \ldots, X_n \) may be written in deviation form as follows:

\[
x_1 = b_{12.34\ldots n}x_2 + b_{13.24\ldots n}x_3 + \ldots + b_{1n,23\ldots (n-1)}x_n
\]

(Regression equation in deviation form for n variables)

\[
X_1 = b_{12.34\ldots n}x_2 + b_{13.24\ldots n}x_3 + \ldots + b_{1n,23\ldots (n-1)}x_n + K
\]

(Regression equation in score form for n variables)

The regression co-efficients \( b_{12.34\ldots n} \), etc., give the weights to be attached to the scores in each of the independent variables when \( X_1 \) is to be estimated from all of these in combination. Furthermore, these regression co-efficients give the weights which each variable exerts in determining \( X_1 \) when the influence of the other variables is excluded.

The correlation between a single variable or criterion \( X_1 \) and \((n-1)\) independent variables combined by means of multiple regression equation is given by the formula:

\[
R^2_{1(23\ldots n)} = \frac{1 - \sigma^2_{123\ldots n}}{\sqrt{\sigma^2_1}}
\]

(multiple correlation coefficient in terms of the partial \( \sigma^2 \)’s for n variables)

Beta coefficients(\( \beta \)) are called beta weights to distinguish them from the score weights of the ordinary multiple regression equation.

\[ R^2 \] may be expressed in terms of beta coefficients and the zero order \( r \)’s;

\[
R^2_{1(23\ldots n)} = \beta_{12.34\ldots n}r_{12} + \beta_{13.24\ldots n}r_{13} + \beta_{1n,23\ldots (n-1)}r_{1n}
\]

(multiple \( R^2 \) in terms of \( \beta \) coefficients and zero order \( r \)’s)

For three variables the above equation becomes

\[
R^2_{1(23)} = \beta_{12.3}r_{12} + \beta_{13.2}r_{13}
\]

(Garrette, 2005)
• If the beta (β) significant value is closer to zero, it is observed that the variables have significant relationship. That is, as variable value increases other variable also increases in the same rate.

• If the beta coefficient (β) is Negative, it means, as variable increases other will significantly decreases.

• It is used to identify the influence of the components of Multiple Intelligence on Science Interest.

• R is Multiple correlation value

• $R^2$ shows that how much % of variation among in the Science Interest can be explained by significant components of Multiple Intelligences.

### 4.8 CONCLUSION

The chapter outlined the design of the present study, the procedure followed and the nature of the sample. It described the hypotheses to be tested, the tools used and the method of administration and scoring. The method of investigation designed and followed were found to be quite appropriate and effective for the study.