CHAPTER IV

METHODOLOGY OF THE STUDY

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4.1 Introduction

Methodology means specific way of performing an operation which leads to the deliverables at the end. “The father of methodology is known as the English philosopher F. Bacon, who first proposed the idea of equipping science with a system of methods.” In this chapter, methodological details of the study are presented. This consists of a body of methods, rules, and postulates.

4.2 Method Adopted for the Study

A survey is a method of collecting information about a human population. In a survey, direct (or indirect) contact is made with the individuals of the study by using systematic methods of measurement such as questionnaires and interviews.

It provides a means of measuring a population’s characteristics, self-reported and observed behavior, awareness of programmes, attitudes or opinions, and needs. Repeating surveys at regular intervals can assist in the measurement of changes over time. Sample surveys gather information from only a portion of a population of interest. The size of the sample depends on the purpose of the study.

In a statistically valid survey, the sample is objectively chosen so that each member of the population will have a non-zero chance of selection. Only then can the results be reliably projected from the sample to the population. The sample should not be selected haphazardly or only from those who volunteer to participate.

Ethical considerations must be observed during the survey exercise. This includes that data is treated confidentially, and information is sought on the understanding that the respondent will not be identified, that their anonymity is preserved. Other ethical considerations include:
• It needs identifiable information relating to respondents for follow-up research. It is needed to explain why to include such details and obtain the consent.

• Respondents would not be adversely affected because of their participation in the survey.

• Survey should be conducted on a voluntary basis.

• It is necessary to get consent of the parents of children under 14 years before interviewing them.

By taking all these precautions as far as possible the investigator decided to adopt survey method for his study. The investigator standardized five tests of multiple intelligence such as test of Linguistic Intelligence, test of Logical-mathematical Intelligence, test of Spatial Intelligence, test of Interpersonal Intelligence and test of Intrapersonal Intelligence. The investigator also standardized one achievement test in Mathematics of standard IX and administered it in different schools of the selected three districts

4.3 Variables of the Study

The variables adopted for the study are

1. Achievement in mathematics as the dependent variable and
2. Linguistic Intelligence
3. Logical-mathematical Intelligence
4. Spatial Intelligence
5. Interpersonal Intelligence and
6. Intrapersonal intelligence as the independent variables
4.4 Population and Sample Selected for the Study

The population includes the set of observations under the target of the study. The sample represents a subset of manageable size. Samples are collected and statistics are calculated from the samples so that one can make inferences or extrapolations from the sample to the population. This process of collecting information from a sample is referred to as sampling. The data sample may be drawn from a population without replacement, in which case it is a subset of a population.

The present study deals with the population as school students of Kerala who are studying in High schools. It includes students studying in Govt High schools, Aided High schools and Unaided High schools of Kerala only. For taking the sample, the investigator took three different districts Kottayam (Middle area), Alappuzha (Coastal area) and Pathanamthitta (Hilly area). The sample contained all relevant strata namely boys and girls, rural and urban, government and private schools. Here the investigator used stratified random sampling as the population contains different strata of different sizes.

4.4.1 Techniques of Sampling

The investigator divided the total sample into different subsamples. These subsamples are taken with respect to gender, locality and management of the school. For this, the investigator selected 25 schools from three districts where he administered the test for the students of standard IX. The names of schools selected for the study are given as Appendix A.
4.4.2 Breakup of the Sample for the Study

The breakup of the sample based on three things

1. Locality
2. Gender
3. Management

4.4.2.1 The breakup of the sample based on Gender

Kerala Education Department publishes the educational statistics every year. The investigator took 2010-2011 as a basic year for his study. According to this the total number of students in Kerala was 4987891. There were 2553568 boys and 2434323 girls. The percentage of boys were 51.1 and that of girls were 48.8.

The percentage of boys studying in Kerala syllabus was 50.7 and that of girls were 49.3. The investigator kept the same ratio as 51% of boys and 49% of girls for his study from the sample.

Table 4.1

*The split up of the sample based on Gender*

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Gender</th>
<th>No. of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Male</td>
<td>764</td>
</tr>
<tr>
<td>2</td>
<td>Female</td>
<td>736</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1500</td>
</tr>
</tbody>
</table>
4.4.2.2 Breakup of the sample based on locality

The total sample is divided into two categories based on locality namely rural and urban. The census report of 2011 shows 17,455,506 as the rural population and 15,932,171 as urban population. For the selection of the sample for the study the investigator tried to keep somewhat same ratio in the sample. The breakup of the sample based on locality is shown in the table 4.2

Table 4.2

The split up of the Students with respect to Locality

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Locality</th>
<th>No.of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rural</td>
<td>720</td>
</tr>
<tr>
<td>2</td>
<td>Urban</td>
<td>780</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1500</td>
</tr>
</tbody>
</table>

4.4.2.3 Breakup of the sample based on Management

The total sample is divided into two categories based on management of schools namely private management and government. There are 1066 government schools and 379 unaided schools in Kerala in the year 2010-2011. The breakup of the sample of based on management is shown in the table 4.3

Table 4.3

The split up of the Students with respect to Management

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Management</th>
<th>No.of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Private</td>
<td>573</td>
</tr>
<tr>
<td>2</td>
<td>Government</td>
<td>927</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1500</td>
</tr>
</tbody>
</table>
4.5 Tools Used for the Study

For the present study the investigator, with the help of the supervising teacher, constructed five tests for measuring five components of multiple intelligences and one achievement test for measuring the achievement of students at secondary level (Standard IX).

Tools used for the study are

1. The test of linguistic intelligence
2. The test of logical mathematical intelligence
3. The test of spatial intelligence
4. The test of interpersonal intelligence
5. The test of intrapersonal intelligence and
6. An achievement test in mathematics

According to Gardner the concept of intelligence is more than a score on a typical standardized paper-pencil test used to make predictions about students in a class or school. Gardner (1999) made an opinion that a musician, an athlete, a social worker, a philosopher exhibit intelligences that are not measured by traditional intelligence test or scale. So the investigator constructed five tests for measuring the components of multiple intelligence with the help of his supervising teacher.
4.6. Description of the Tools

4.6.1 Standardization of a Test of Linguistic Intelligence

4.6.1.1 Planning of the Test

The test to measure the linguistic intelligence was developed by the investigator with the help of the supervising teacher. Each subject has its own language. The ability to handle any language skillfully may be treated as linguistic intelligence. For Chemistry there is a chemical language, for mathematics there is a mathematical language and for computer there is a computer language. According to Vygotsky, “words are signals rather than engage children in a primary signal system in which objects are referred to merely as themselves, adults engage children in a secondary signal system, in which words represent objects and ideas”. (Vygotsky 1978)

Here the scale of linguistic intelligence is developed by the investigator by using Likert-method. The investigator constructed the items for the test based on the specific dimensions stipulated by Gardner. The test is also made appropriate to the age level of secondary school students of Kerala. The investigator prepared 95 statements, both positive and negative, for the test. Here the examinee had to indicate the degree of presence of their ability on a 5-point scale. Here rating provided for the respondents ranges from strongly disagree to strongly agree. These 95 statements were presented before a group of experts. After considering their suggestions 70 statements were selected for the final test. After making discussions with the supervising teacher, the investigator made the draft form of the scale of linguistic intelligence as text booklet. The draft is given in Appendix B.
4.6.1.2 Pilot Study

This comprises of two steps. 1. Selection of sample  2. Administration of the test of Linguistic Intelligence.

4.6.1.2.1 Selection of the Sample

The draft of the test of Linguistic Intelligence is administered to a sample of 370 students. The sample was a due representation of the population in terms of gender, locality and management. For the standardization of test of linguistic intelligence, the investigator took 370 students for preliminary testing. The students were selected from various districts of Kerala, namely Kottayam (Middle area), Alappuzha (Coastal area) and Pathanamthitta (Hilly area). The sample represented the population by keeping the same ratio.

4.6.1.2.2 Administration of the test of linguistic intelligence

The investigator administered the test in the above mentioned schools. Uniform procedures were followed in all the schools selected. The following aspects were included before administration of the test.

1. Allowed the students to read carefully all the relevant instructions given.
2. Gave a good explanation to the students how to enter their responses.
3. Cleared all the doubts regarding the statements.
4. Strict discipline was followed while answering the test.
5. Appropriate time was given to the students for entering their response.
4.6.1.3 Scoring of the Test of Linguistic Intelligence

Responses of the statements of the test was on a five point scale as shown in the table 4.4. The maximum mark for a positive statement is 5.

Table 4.4

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Answer positions</th>
<th>Positive statements</th>
<th>Negative statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Strongly Agree</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>Agree</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>Undecided</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>Disagree</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>E</td>
<td>Strongly Disagree</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

The total score of a student was obtained by adding the score of each individual items.

4.6.1.4 Item Analysis of the test of Linguistic Intelligence

By using Likert method of summated ratings the items were analysed. List out the highest 27% and lowest 27% through item analysis. There were 100 students in each group. The t value for each item was calculated by using the formula. The items having t value equal to or greater than 1.75 were selected for final form of the scale. This was done by using the following formula.
Methodology

\[ t = \frac{\bar{X}_u - \bar{X}_l}{\sqrt{\frac{\sum (X_u - \bar{X}_u)^2 + \sum (X_l - \bar{X}_l)^2}{n(n-1)}}} \]

\[ \sum (X_u - \bar{X}_u)^2 = \sum X_u^2 - \left( \frac{\sum X_u}{n} \right)^2 \]

\[ \sum (X_l - \bar{X}_l)^2 = \sum X_l^2 - \left( \frac{\sum X_l}{n} \right)^2 \]

Xu  Mean score on a given statement in upper group
XL  Mean score on a given statement in lower group
X   Mean score on a given statement in upper group
XL  Mean score on a given statement in lower group

4.6.1.5 Preparation of the final test of Linguistic Intelligence

The investigator prepared the final test by choosing 25 items from the above test items

4.6.1.6 Distribution of items in the Linguistic Scale

Table 4.5

<table>
<thead>
<tr>
<th>Sel. No. of items</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2, 5, 8, 9, 13, 17, 23, 26, 28, 29, 31, 34, 37, 42, 53, 55, 56, 57, 60, 62, 65, 67, 69, 70,</td>
<td>25</td>
</tr>
</tbody>
</table>
4.6.1.7 Arrangement of items of the final test of Linguistic Intelligence

The investigator arranged the items in final test of linguistic Intelligence and final printout was taken. For the final administration of the test the investigator took the sample as follows

4.6.1.8 Selection of sample for the final test of Linguistic Intelligence

The investigator took the sample for the final administration by maintaining the same ratio of the total population of Kerala. It also maintained the same ratio of the population for the case of male female, rural urban and government and private school students. The sample was selected from three districts of Kerala 1) Alappuzha 2) Kottayam and 3) Pathanamthitta, which were the representations of coastal area, middle area and hilly area.

Two related concepts, validity and reliability, need to be found out for evaluating all assessment activity, including standardized testing. The Final form of the test of Linguistic Intelligence is given in Appendix C.

4.6.1.9 Evaluation of the test

While constructing any test or tool, evaluation is for making confidence in the result of the test. This confidence develops only when it yields reasonably consistent results with adequate degree of accuracy.

4.6.1.10 Validity

By Crooks, Kane, and Cohen (1996) validity is ‘the most important consideration in the use of assessment procedures’ According to Standards for Educational and Psychological Testing, Validity refers to the degree to which
Methodology

Evidence and theory support the interpretation of test scores. It is the interpretation of test scores required by proposed uses that are evaluated, not the test itself. When test scores are used to interpret in more than one way, each intended interpretation must be validated. The investigator prepared the items for the test with the help of experts in the field so as to make sure the validity of the test.

4.6.1.11 Reliability

According to the Standards for Educational and Psychological Testing (AERA, APA, NCME, 1999), reliability refers to consistency of the measurement when a testing procedure is repeated on a population of individuals or groups. Central to this is the concept of measurement error – the unsystematic error that arises because a student is tested on a particular set of items in a particular context. The investigator found the reliability by using split half method. The reliability coefficient was 0.68.

4.6.2 Standardization procedure of the test of Logical-mathematical Intelligence

4.6.2.1 Planning of the test logical-mathematical intelligence

The investigator with the help of supervising teacher prepared a standardized test in logical-mathematical intelligence. This test has to measure the logical thinking, ability to work with numbers, ability to find cause effect relationship etc. Statements are constructed for finding these abilities. For developing the scale of logical-mathematical intelligence, Likert-method is used. At first 90 statements were constructed, both positive and negative, for the test. Then this is submitted before a panel of experts. According to their suggestions 20 of them were omitted. The investigator constructed the items for the test based on the specific dimensions
Methodology

stipulated by Gardner. The test is also made appropriate to the age level of secondary school students of Kerala. Here the examinee had to indicate the degree of presence of their ability on a 5-point scale. Here rating provided for the respondents ranges from strongly disagree to strongly agree. Finally 70 statements were taken for the final test. The investigator after discussing with the supervising teacher prepared the final form of the scale of Logical-Mathematical Intelligence in a text booklet form.

4.6.2.2 Pilot Study

This comprises of two steps 1. Selection of sample 2. Administration of the test of logical-mathematical intelligence

4.6.2.2.1 Selection of the sample for pilot study

For the standardization of test of Logical mathematical intelligence, the investigator took 370 students for preliminary testing. The students were selected from various districts of Kerala, namely Kottayam (Middle area), Alappuzha (Coastal area) and Pathanamthitta (Hilly area). The sample represents the population by keeping the same ratio.

4.6.2.2.2 Administration of the test

The investigator administered the test in different schools as given below. The sample represents the population by keeping the same ratio. Then sample contained all relevant strata namely boys and girls, rural and urban, government and private schools. The details are given in Appendix D.
4.62.3 Fixation of marks of the Test of Logical-Mathematical Intelligence

Responses of the statements of the test was on a five point scale as shown in the table given below. The investigator used a 5 point scale for scoring.

Table 4.6

**Score value distribution of test items**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Answer positions</th>
<th>Positive statements</th>
<th>Negative statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Strongly Agree</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>Agree</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>Undecided</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>Disagree</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>E</td>
<td>Strongly Disagree</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

After making discussions with the experts the investigator made 70 items. It was administered on a sample of the 370 high school students of the above mentioned schools of Kerala. The investigator used stratified random sampling. Uniform procedures were followed in all the schools selected. The following aspects were included before distribution of the test.

1. Gave necessary time for reading the relevant instructions given.
2. The investigator gave good explanation to the students how to enter their responses.
3. It was made sure that all the students have mathematical instruments with them.

4. A strict discipline was maintained while the examination is going on.

4.6.2.4 Item Analysis

After the test administration the items were analysed and listed out the highest 27% and lowest 27%. There were 100 students in each group. By using Likert method of summated ratings the items were analysed. The t value for each item was calculated by using the formula

\[
t = \frac{\bar{X}_U - \bar{X}_L}{\sqrt{\frac{\Sigma(X_U - \bar{X}_U)^2 + \Sigma(X_L - \bar{X}_L)^2}{n(n-1)}}}
\]

\[
\Sigma(X_U - \bar{X}_U)^2 = \Sigma X_U^2 - \left(\frac{\Sigma X_U}{n}\right)^2
\]

\[
\Sigma(X_L - \bar{X}_L)^2 = \Sigma X_L^2 - \left(\frac{\Sigma X_L}{n}\right)^2
\]

Xu    Mean score on a given statement in upper group
XL    Mean score on a given statement in lower group
X     Mean score on a given statement in upper group
XL    Mean score on a given statement in lower group

4.6.2.5 Preparation of the final test

After careful scrutiny the investigator got numerous eligible items for the final test. The investigator prepared the final test by choosing 25 items from the above test items. Details given in the table below
4.6.2.6 Arrangement of items of the test of Logical –Mathematical Intelligence

The investigator arranged the items of the final test carefully and necessary copies were taken.

4.6.2.7 Selection of sample for the final test of Logical –Mathematical Intelligence

The investigator took the sample for the study by maintaining the same ratio of the total population of Kerala. It also maintained the same ratio of the population for the case of rural urban and government and private school students. The sample was selected from three districts of Kerala: 1) Alappuzha 2) Kottayam and Pathanamthitta, which were the representations of coastal area, middle area and hilly area. School Details are below in Appendix A.

4.6.2.8 Administration of the final test of Logical –Mathematical Intelligence.

The investigator administered test in various schools of the above three districts. The final form of the Test of Logical mathematical Intelligence is given in Appendix E.
4.6.2.9 Evaluation of the test of Logical –Mathematical Intelligence

There are number of dimensions on which almost any test can be judged. One of the evaluative factor is validity and the other is reliability.

4.6.2.10 Validity of the test of Logical –Mathematical Intelligence

Generally we associate the concept of validity with the extent to which a test measures what it purports to measure. Because the times in the test were developed through systematic procedure and help from experts, it fulfilled the validity of the test.

4.6.2.11 Reliability of the test of Logical –Mathematical Intelligence

A test is reliable if it is consistently yield the same result, or nearly the same result over repeated administrations. The investigator found out the reliability using test-retest method. The reliability coefficient was 0.84.

4.6.3 Standardization of the Test of Spatial Intelligence

4.6.3.1 Planning of the test

A scale of Spatial Intelligence was developed by the investigator through the help of the supervising teacher. According to Gardiner, spatial intelligence is the ability to make sense of the space. While a human being writing an essay or a paragraph in a paper, he will have to omit some space in the right side of the paper in each line. This is why because he cannot write the next word fully in that space. This recognition is a form of spatial ability.

In mathematics while a student has to write even numbers or odd numbers from mind he uses spaces between numbers. There are cases when students have to
make mental imagery of their observed patterns. Some students have to develop artistic thinking. Some have to construct different geometrical figures. Some have to draw different types of graphs. There are situations for making different mathematical models. All these activities are supposed to be based on some spatial awareness.

To assess the spatial intelligence the investigator standardized a test of spatial intelligence. First the investigator constructed 93 statements, both positive and negative, for the test. Then presented these statements before a group of experts. After considering their opinion, some items were rejected. Finally 70 items were selected for the final test. The test is also made appropriate to the age level of the secondary school students of Kerala. Here the examinee had to indicate the degree of presence of their ability on a 5-point scale. Here rating provided for the respondents ranges from strongly disagree to strongly agree.

For the standardization of test of Spatial intelligence, the investigator took 370 students for preliminary testing. The students were selected from various districts of Kerala, namely Kottayam (Middle area), Alappuzha (Coastal area) and Pathanamthitta (Hilly area). The sample represents the population by keeping the the same ratio.

4.6.3.2 Pilot study

This comprises of two steps 1) Selection of sample 2) Administration of the test of Spatial Intelligence.
4.6.3.2.1 Selection of sample

The investigator conducted the study on different schools of the above mentioned schools. The sample represents the population by keeping the same ratio. Then sample contained all relevant strata namely boys and girls, rural and urban, government and management schools.

4.6.3.2.2 Administration of the test of Spatial Intelligence

Uniform procedures were followed in all the schools selected. The following aspects were included before distribution of the test.

1. Enough time was given for reading carefully all the specific instructions given.
2. The investigator gave relevant direction about how to enter their responses.
3. Never allowed the students to use any instrument other than pen.
4. Not allowed any malpractices.
5. Only allotted time was given for giving the responses.

Responses of the statements of the test was on a five point scale as shown in the table given below. Draft form of the test is given in Appendix F.

4.6.3.3 Scoring of the Test of Spatial Intelligence

The investigator used a 5 point scale for scoring.

Responses of the statements of the test was on a five point scale as shown in the table given below.
Table 4.8

*Score value distribution of test items*

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Answer positions</th>
<th>Positive statements</th>
<th>Negative statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Strongly Agree</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>Agree</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>Undecided</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>Disagree</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>E</td>
<td>Strongly Disagree</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

4.6.3.4 Tryout

At first the investigator made 70 items with the help of the supervising teacher. It is administered on a sample of 370 high school students of the above mentioned schools of Kerala.

4.6.3.5 Item Analysis

After the test administration the items were analysed and listed out the highest 27% and lowest 27%. There were 100 students in each group. By using Likert method of summated ratings the items were analysed.

The t value for each item was calculated by using the formula
\[ t = \frac{\bar{X}_U - \bar{X}_L}{\sqrt{\frac{\sum (X_U - \bar{X}_U) + \sum (X_L - \bar{X}_L)}{n(n-1)}}} \]

\[ \sum (X_U - \bar{X}_U)^2 = \sum X_U^2 - \left( \frac{\sum X_U}{n} \right)^2 \]

\[ \sum (X_L - \bar{X}_L)^2 = \sum X_L^2 - \left( \frac{\sum X_L}{n} \right)^2 \]

Xu  Mean score on a given statement in upper group

XL  Mean score on a given statement in lower group

X  Mean score on a given statement in upper group

XL  Mean score on a given statement in lower group

### 4.6.3.6 Preparation of the final test

The investigator prepared the final test by choosing 25 items from the above test items. The final form the test of Spatial Intelligence is given in Appendix G.

### 4.6.3.7 Items selected for final test of Spatial Intelligence

The investigator prepared the final test by choosing 25 items from the above test items. The investigator carefully arranged items and took copies according to the number of students.
4.6.3.8 Selection of sample for the final test

The investigator took the sample for the study by maintaining the same ratio of the total population of Kerala. It also maintained the same ratio of the population for the case of rural urban and government and private school students. The sample was selected from three districts of Kerala: 1) Alappuzha, 2) Kottayam, and 3) Pathanamthitta, which were the representations of coastal area, middle area, and hilly area.

4.6.3.9 Administration of the final test

The investigator administered the test in various schools of the above three districts.

4.6.3.10 Evaluation of the test

While constructing any test or tool, evaluation is for making confidence in the result of the test. This confidence develops only when it yields reasonably consistent results with adequate degree of accuracy. So we should seriously consider the validity and reliability of the test.
4.6.3.11 Validity

Validity makes sure that whether a test supplies the kind of information needed for a particular interpretation. Here the investigator used the help of experts in the field for framing questions so as to make sure the validity.

4.6.3.12 Reliability

Reliability refers to the level of stability in the value of scores which elicits from an instrument. Here the investigator used test-retest method for finding reliability. The reliability coefficient is 0.99.

4.6.4 Standardization of the Test of Inter-Personal Intelligence.

4.6.4.1 Planning of the Test

The scale of Interpersonal intelligence was developed by the investigator with the help of the supervisor. The interpersonal intelligence means the ability to interact or to understand another person. It also deals with making empathy with others, to appreciate others, to interact with others, to follow others, to advise others etc. As a student in the class each one has to cooperate with other students. For solving a difficult or diverging problem one student can interact with other students or with teachers.

At first the investigator developed 95 statements, both positive and negative, for the test. Then this is submitted before a group of experts for getting their opinion. After discussion with the experts 25 items were rejected. The remaining 70 items were selected for the final test. The test is also made appropriate to the age level of the secondary school students of Kerala. Here the examinee had to indicate the degree of
presence of their ability on a 5-point scale. Here rating provided for the respondents ranges from strongly disagree to strongly agree. After considering the suggestions from the supervising teacher the investigator prepared the final test in a text booklet form. The draft form is given in Appendix H.

4.6.4.2 Pilot Study

This comprises of two steps 1. Selection of sample and 2. Administration of the test of Interpersonal intelligence

4.6.4.2.1 Selection of sample

For the standardisation of test of Interpersonal intelligence, the investigator took 370 students for preliminary testing. The students were selected from various districts of Kerala, namely Kottayam (Middle area), Alappuzha (Coastal area) and Pathanamthitta (Hilly area). The sample represents the population by keeping the same ratio.

4.6.4.2.2 Administration of the test of Interpersonal intelligence

The investigator conducted the study on different schools of the above mentioned schools. The sample represents the population by keeping the same ratio. Then sample contained all relevant strata namely boys and girls, rural and urban, government and management schools. The draft form of the test is given in Appendix I.

Uniform procedures were followed in all the schools selected. The following aspects were included before distribution of the test.
1. The investigator carefully arranged the seating of the students in the class for avoiding malpractices.

2. A brief explanation was given to the students about the way of entering their responses.

3. Rectified all the doubts regarding the statements of the test.

4. The service of the teachers was also used.

5. Necessary time was given to the students for giving their response.

4.6.4.3 Scoring Approach

The investigator used a 5 point scale for scoring.

4.6.4.4 Scoring of the Test of Interpersonal Intelligence

Responses of the statements of the test was on a five point scale as shown in the table given below.

Table 4.10

Score value distribution of test items

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Answer positions</th>
<th>Positive statements</th>
<th>Negative statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Strongly Agree</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>Agree</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>Undecided</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>Disagree</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>E</td>
<td>Strongly Disagree</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

By using Likert method of summated ratings the items were analysed.
4.6.4.5 Item Analysis

After the test administration the items were analysed and listed out the highest 27% and lowest 27%. There were 100 students in each group. The t value for each item was calculated by using the formula

\[
t = \frac{\bar{X}_u - \bar{X}_l}{\sqrt{\frac{\sum (X_u - \bar{X}_u)^2 + \sum (X_l - \bar{X}_l)^2}{n(n - 1)}}}
\]

\[
\sum (X_u - \bar{X}_u)^2 = \sum X_u^2 - \left(\frac{\sum X_u}{n}\right)^2
\]

\[
\sum (X_l - \bar{X}_l)^2 = \sum X_l^2 - \left(\frac{\sum X_l}{n}\right)^2
\]

Xu Mean score on a given statement in upper group
XL Mean score on a given statement in lower group
X Mean score on a given statement in upper group
XL Mean score on a given statement in lower group

4.6.4.6 Preparation of the final test

The investigator prepared the final test by choosing 25 items from the above test items. The investigator copied the appropriate items in a paper and printout was taken. The following items were included.

4.6.4.7 Items selected for final test of Interpersonal Intelligence

Table 4.11

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Sel. No. of items</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2, 6, 8, 11, 14, 18, 28, 30, 34, 37, 40, 44, 46, 48, 52, 53, 56, 58, 59, 61, 62, 63, 64, 66, 70.</td>
<td>25</td>
</tr>
</tbody>
</table>
4.6.4.8 Selection of sample for the final test

The investigator took the sample for the study by maintaining the same ratio of the total population of Kerala. It also maintained the same ratio of the population for the case of rural urban and government and private school students. The sample was selected from three districts of Kerala 1) Alappuzha 2) Kottayam and Pathanamthitta, which were the representations of coastal area, middle area and hilly area.

4.6.4.9 Administration of the final test.

The investigator administered test in various schools of the above three districts.

4.6.4.10 Evaluation of the test

While constructing any test or tool, evaluation is for making confidence in the result of the test. This confidence develops only when it yields reasonably consistent results with adequate degree of accuracy. So we should seriously consider the validity and reliability of the test.

4.6.4.11 Validity of the test

Validity is sure when a test accurately represents content and depth of learning intended by the test. Here the investigator accepted expert opinions for constructing items of the test so as to make sure the validity.
4.6.4.12 Reliability

A test result must be repeatable to be confident so that a student score is a true reflection of this behaviour. The investigator used test-retest method for finding the reliability. The reliability coefficient is 0.99.

4.6.5 Standardization of the Test of Intra-Personal Intelligence.

4.6.5.1 Planning of the test

Through the help of the supervising teacher the investigator developed a scale of intrapersonal intelligence. Intrapersonal intelligence reflects when one can think about himself and understand one’s own self. For achieving some goals one must know his own strengths and weakness. There are students who work for themselves only. As a student one has to solve problems which are divergent in nature. So deep thinking is necessary. All our findings are emerged from man’s deep thinking. There are some students who may have this quality. To measure their intrapersonal intelligence the investigator constructed 94 statements, both positive and negative. Then the investigator placed these statements before a panel of experts to find fault with it. After considering their opinion, 24 items were omitted. Considering the suggestions from the supervising teacher 70 statements were selected for the final test. The test is also made appropriate to the age level of the secondary school students of Kerala. Here the examinee had to indicate the degree of presence of their ability on a 5-point scale. Here rating provided for the respondents ranges from strongly disagree to strongly agree.
4.6.5.2 Pilot study

This comprises of two steps 1. Selection of sample and 2. Administration of the test of Intra-Personal Intelligence

4.6.5.2.1 Selection of Sample

For the standardization of test of Intrapersonal intelligence, the investigator took 370 students for preliminary testing. The students were selected from various districts of Kerala, namely Kottayam (Middle area), Alappuzha (Coastal area) and Pathanamthitta (Hilly area). The sample represents the population by keeping the same ratio. The investigator conducted the study on different schools of the above mentioned schools. The sample represents the population by keeping the same ratio. Then sample contained all relevant strata namely boys and girls, rural and urban, government and private schools.

4.6.5.2.2 Administration of the test of Intra-Personal Intelligence

At first the investigator made 70 items. It is administered on a sample of 370 high school students of the above mentioned schools of Kerala. The investigator used Stratified random sampling. The draft copy of the test is given as Appendix J.

4.6.5.3 Scoring of the Test of Intra-Personal Intelligence

Responses of the statements of the test was on a five point scale as shown in the table given below.
Table 4.12

Score value distribution of test items

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Answer positions</th>
<th>Positive statements</th>
<th>Negative statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Strongly Agree</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>Agree</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>Undecided</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>Disagree</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>E</td>
<td>Strongly Disagree</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

4.6.5.4 Item Analysis

After the test administration the items were analysed and listed out the highest 27% and lowest 27%. There were 100 students in each group. By using Likert method of summated ratings item analysis the items are analysed.

After the test administration the items were analysed. List out the highest 27% and lowest 27% through item analysis here were 100 students in each group. The t value for each item was calculated by using the formula

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

\[
\sum(X_U - \bar{X}_U)^2 = \sum X_U^2 - \left(\frac{\sum X_U}{n}\right)^2
\]
$$\Sigma (X_L - \bar{X}_L)^2 = \Sigma X_L^2 - \left(\frac{\Sigma X_L}{n}\right)^2$$

\[\text{X}_u \quad \text{Mean score on a given statement in upper group}\]

\[\text{X}_L \quad \text{Mean score on a given statement in lower group}\]

\[\text{X} \quad \text{Mean score on a given statement in upper group}\]

\[\text{X}_L \quad \text{Mean score on a given statement in lower group}\]

4.6.5.5 Preparation of the final test of Intra-Personal Intelligence

After the pilot study numerous items were obtained as eligible. The investigator prepared the final test by choosing 25 items from the above test items.

4.6.5.6 Items selected for final test of Intrapersonal Intelligence

Table 4.13

*Items selected for final test of Intrapersonal Intelligence*

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Sel. No. of items</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,2 3, 6, 7, 11, 12, 19, 20, 26, 28, 29, 30, 35, 43, 47, 49, 51, 52, 59, 61, 63, 65, 69</td>
<td>25</td>
</tr>
</tbody>
</table>

4.6.5.7 Selection of sample for the final test

The investigator took the sample for the study by maintaining the same ratio of the total population of Kerala. It also maintained the same ratio of the population for the case of rural urban and government and private school students. The sample was selected from three districts of Kerala 1) Alappuzha 2) Kottayam and
Pathanamthitta, which were the representations of coastal area, middle area and hilly area.

4.6.5.8 Administration of the final test.

The investigator administered test in various schools of the above three districts. The final form of the test is given in Appendix K.

4.6.5.9 Evaluation of the test

After constructing any test for making confidence in the result evaluation is necessary. This makes the test to supply reasonably consistent results with adequate degree of accuracy. So we should consider the validity and reliability of the test.

4.6.5.10 Validity

Validity is the ability of the test items to give valid results. For making the items of the test the investigator sought help from experts so as to make sure the validity of the test.

4.9.5.11 Reliability

Reliability means the truthfulness of the test. The investigator found out the reliability by using test-retest method. The reliability coefficient is 0.95.

4.9.6 Standardization of the Achievement Test in Mathematics

4.9.6.1 Planning of the test

The present study is conducted for finding the relationship between multiple intelligence and achievement in Mathematics of students at secondary level schools of Kerala. Since standard VIII is the beginning stage and standard X is the final
stage of the secondary level, the investigator selected standard IX for conducting the study. The investigator has to standardize an achievement test in mathematics for standard IX.

General guidelines for developing multiple choice items are as follows

Multiple choice items can measure different kinds of knowledge, understanding of terminology, facts, principles, methods and procedures. It also measures the ability to apply, interpret and justify things. When carefully designed multiple choice items can assess higher order thinking skills. Multiple choice items are less ambiguous. It provides a deep focused assessment of student knowledge. It is more reliable than true/false items. The opportunity for guessing is minimized with the larger number of options. A teacher can diagnose misunderstanding by analyzing the incorrect options written by students. Some difficulties in making multiple choice items are that they require developing incorrect but seems like correct answers as options. It is a difficult job for the teacher to construct a multiple choice test. (Gronlund & Linn, 1990). Different steps included the construction of present achievement test are

4.6.6.1.1 Designe of the test

4.6.6.1.1.1 Weightage to Objectives

The investigator discussed with experts for giving appropriate weightage to objectives. Then decided to test all objectives under cognitive domain and one objective from psychomotor domain. The objectives selected from cognitive domain are knowledge, understanding, application, analysis, synthesis and evaluation. The objectives selected from psychomotor domain is skill. They were taken from the Blooms Taxonomy (1956) of educational objectives.
### Table 4.14
Weightage to Objectives

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Objectives</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Understanding</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Application</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>Analysis</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>Synthesis</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>Evaluation</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>7</td>
<td>Skill</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>50</td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

#### 4.6.6.1.1.2 Weightage to content

While designing the test the investigator consulted with school teachers and experts in the school curriculum for giving due weightage to content.

### Table 4.15
Weightage to content

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Content</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>പലഘണങ്ങൾ (Polygons)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>വൃത്തങ്ങൾ (Circles)</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>അർഥമുള്ള സംഖ്യകൾ (rational numbers)</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>രേഖാതും രേഖാത്തുകൾ (pair of equations)</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>വിസ്തീർണ്ണ് (Area)</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>6</td>
<td>അവകാശമുള്ള സംഖ്യകൾ (Irrational numbers)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>സാംസ്കൃതിക വിശ്ലേഷണം (Statistics)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>50</td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
4.6.6.1.3 Weightage to form of questions

The investigator decided to construct objective type questions for the test. Multiple choice questions were constructed. Objective type items demand the examinee the answer the question by a word or a phrase. All questions were objective type question.

4.6.6.1.4 Weightage to difficulty level of questions

Since in a class the number of students in average level is supposed to be more than that of below average and above average, more number of items were constructed on average level.

Table 4.16

Weightage to difficulty level of question

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Level of difficulty</th>
<th>Mark</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Easy</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>average</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>Difficult</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

4.6.6.2 The Blueprint of the test

The Blueprint includes three components in three dimensions. These components are objectives selected, form of questions and content on which the test is to be prepared. The blueprint was shown below.
Table 4.17

The Blueprint of the test

<table>
<thead>
<tr>
<th>Objectives</th>
<th>K</th>
<th>U</th>
<th>Ap</th>
<th>An</th>
<th>Sy</th>
<th>Ev</th>
<th>Sk</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form of question</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>ഗണിതശാസ്ത്രം</td>
<td>2 (2)</td>
<td>1 (1)</td>
<td>2 (2)</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>പ്രത്യേകത</td>
<td>2 (2)</td>
<td>6 (6)</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>രണ്ടാം വിഭാഗം</td>
<td>4 (4)</td>
<td>2 (2)</td>
<td>4 (4)</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>മൂന്നാം വിഭാഗം</td>
<td>10 (10)</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>കുറി</td>
<td>2 (2)</td>
<td>3 (3)</td>
<td>2 (2)</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>നാലാം വിഭാഗം</td>
<td>1 (1)</td>
<td>4 (4)</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>പിന്നിട്ട് വിഭാഗം</td>
<td>1 (1)</td>
<td>3 (3)</td>
<td>1 (1)</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>5</td>
<td>20</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>50</td>
</tr>
</tbody>
</table>

O = Objective type questions


4.6.6.3 Construction of test items

For constructing the test items the investigator discussed with the teachers in the school and analyzed the topic in standard IX Mathematics text. Some general principles followed while making test items are

1. Each question is based on a specific objective

2. Used simple language

3. Avoided sentences and questions directly as it is in the text book

4. Tried to avoid getting clues from answers of other questions
The investigator constructed 75 items for the test with the help of his supervising teacher.

4.6.6.4 Arrangement of Questions

The investigator arranged the questions based on the order of difficulty from easy to difficult.

4.6.6.5 Preparation of a scoring key

Scoring key is a table containing the question number in the first column and the corresponding answers in the second column. The investigator prepared a scoring key for the test.

4.6.6.6 Pilot Study

This includes the following steps. 1. Selection of sample 2 Administration of the test

4.6.6.6.1 Selection of Samples

The sample selected for administering the preliminary test was taken from three districts of Kerala viz., Kottayam (middle area), Allappuzha (coastal area) and Pathanamthitta (hilly area). The sample contains all relevant strata names boys and girls, rural and urban and also government and management schools.

Administration of the test

For the standardization, the investigator took 370 students for preliminary testing. The draft form of the achievement test in Mathematics is given in Appendix L.
4.6.6.7 Item Analysis

Item analysis is used to identify items which are deficient in some way. There are two types of items analysis 1. Qualitative item analysis 2. Quantitative item analysis. Qualitative item analysis means editing poorly written test items. Quantitative item analysis is a technique which will enable us to determine the quality of an item. Quantitative item analysis is ideal for examining the usefulness of multiple choice items. (Tom, Kubiszyn and Gary Borich)

Item analysis includes determination of two characteristics of an item. One of them is the ‘discriminating index’ and other is ‘difficulty index’.

4.6.6.8 Discriminating index

This is a measure of the extent to which a text item discriminate between students who are well or do not well on the overall test.

The formula for finding discrimination index is

\[ DI = \frac{U - L}{N} \]

\( U = \) Number of students in the upper group who gave correct answer to the test item

\( L = \) Number of students in the lower group who gave correct answer to the test item

\( N = \) Number of students in one group

4.6.6.9 Difficulty index

This indicates the proportion of students who gave answers to questions as correctly. It is determined by the formula
Methodology

\[ DP = \frac{U + L}{2N} \]

After the test administration, the items were analysed and listed out the highest 27% and lowest 27%. There were 100 students in each group. The discriminating power is determined by using the formula \( \frac{(U - L)}{N} \) and the difficulty index were found out by using the formula \( \frac{(U + L)}{2N} \). The investigator selected 25 items having discriminating power as 0.3 and above. He also made sure the difficulty index of these items are between 0.3 and 0.4.

4.6.6.10 Preparation of the final test

Out of 70 items the investigator selected 50 items in accordance with the blueprint and suggestions of the supervising teacher. The items were selected so that the students can answer it in within two hours. (Frisbe 1971). The final test was printed in the form of a text booklet with necessary indication of instructions. The final form of the achievement test is given in Appendix M.

4.6.6.11 Selection of sample for the final test

The investigator took the sample for the study by maintaining the same ratio of the total population of Kerala. It also maintained the same ratio of the population for the case of rural urban and government and private school students. The sample was selected from three districts of Kerala 1) Alappuzha 2) Kottayam and 3) Pathanamthitta, which were the representations of coastal area, middle area and hilly area.
4.6.6.11 Administration of the final test.

The investigator administered test in various schools of the above three districts.

4.6.6.12 Scoring

The investigator scored the answer scripts by himself.

4.6.6.13 Evaluation of the Achievement Test

Evaluation is the procedure which makes sure the quality of some thing. For this we must have a measure or test of some characteristics. The we can compare it with against established criteria to determine whether it is excellent, good, adequate or unacceptable.

There are two criteria for evaluating test. One of it is the consistency with which it produces the same results under same conditions. The second criterion is whether it actually measures the characteristics that is supposed to measure. These two are known as validity and reliability.

4.6.6.14 Reliability of the test

Reliability refers to the stability of the test scores. The investigator determined the reliability of the achievement test by using test-retest method. For that the investigator took 100 students from the sample. Then administered the test for the sample. The reliability coefficient is 0.86.
4.6.6.15 Validity of the test

Validity is the appropriateness of inferences made from student’s test results. A test can give valid decisions from its results only then it has validity. The following things are considered by the investigator.

4.6.6.15.1 Content Validity

Made sure that the skills measured accurately represent the goal of the domain. This involves the content validity. The investigator analyze all the objectives and content area and make sure the content validity.

4.6.6.15.2 Statistical Validity

The investigator collected the scores of 100 students in their annual examination and find correlation between these scores and the scores of achievement test. The correlation coefficient was found to be 0.7. So the test satisfied statistical or empirical validity.

4.6.6.15.3 Construct Validity

The syllabus allotted for Standard IX mathematics will be according to the mental level of students at Standard IX. So it is expected that they are able to give answer to the achievement test so made sure the construct validity.

4.6.6.16 Objectivity

Objectivity means definitiess in the answer expected. Since all the test items are objective type the objectivity is ensured.
4.6.6.17 Practicability

The achievement test constructed by the investigator has the following practical considerations

1. The test is simple to administer.

2. Interpretations of result is easy.

3. The scoring key is reusable.

4. The time required for answering the test is practicably feasible.

4.7 Procedure for Collection of Data

The sample was selected from three districts of Kerala, namely Kottayam (Middle area), Alappuzha (Coastal area) and Pathanamthitta (Hilly area). The sample contained all relevant strata namely boys and girls, rural and urban, government and private schools. The investigator collected the data using survey method. The investigator decided to administer the above mentioned five tests in various schools of the above three districts of Kerala. The investigator made adequate number of printed copies of the test of linguistic intelligence, test of logical-mathematical intelligence, test of spatial intelligence, test of interpersonal intelligence, test of intrapersonal intelligence and the achievement test in mathematics. The investigator distributed these to 1650 students in the above mentioned districts.

4.8 Statistical Techniques used for the Study

The collected data were analysed using suitable statistical techniques. The statistical techniques chosen are given as follows
The statistical techniques used were

4.8.1 The descriptive statistics

The descriptive statistics, mean, SD, skewness, and kurtosis were used to find the Critical Ratio between the achievement in Mathematics and selected components of multiple intelligences.

4.8.2 t test is used for finding the critical ratio and for item analysis

The formula

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

was used for item analysis.

4.8.3 One sample t-test was used for testing the significance of the level of the students with respect to variables. This was done by using the formula

\[
t = \frac{x - \text{test value}}{s\sqrt{n}}
\]

4.8.4 Chi-square test and Karl Pearson’s Coefficient of Correlation were used for studying the relationship between independent variables and achievement in Mathematics.

\[
\text{Chi-square} \quad \Sigma = \frac{(e_i - f_i)^2}{e_i f_i}
\]

4.8.5 Independent sample t-test was used to test the significance of difference in sub samples.

4.8.6 Multiple Regression Analysis was used to study the effectiveness of all the independent variables together to predict the achievement in Mathematics.
4.8.7 Fisher’s Z transformation test for equality of correlation coefficients

To test the equality of correlation coefficients, Fisher’s Z transformation of the correlation coefficient $r$ is used. It is often denoted by $r'$

$$r' = 0.5 \times \log_e \{\text{Abs}([1 + r]/[1 - r])\}$$

where Abs($x$) is the absolute value of $x$. The standard error of $r'$ is denoted $s_{r'}$ and has a value of $1/\sqrt{N - 3}$, where $\sqrt{x}$ means the square root of $x$, and $N$ is the number of subjects involved in the correlation.

We can calculate a z-statistic for the difference between two $r'$ values:

$$Z = (r'_1 - r'_2) / \sqrt{1/(N_1 - 3) + 1/(N_2 - 3)}$$