Chapter IV

METHODOLOGY

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METHODOLOGY

Methodology is a procedure or technique used by the investigator for conducting an investigation. It lays out the way that formal research is to be carried out, and outlines the details of the description of the research variables and procedures. According to Lincoln & Guba (2000),¹ “Method or methodology applies in correspondence with the assumption about the social interaction between and among investigator and respondents”. It refers to the study design through which the validity of elements is to be established. A suitable method helps the researcher to explore the various dimensions of the study. The reliability and validity of the findings also depends up on the method adopted and hence methodology occupies a very important place in the field of any research.

The present study was primarily intended to investigate the effect of Kolb’s Experiential Learning Model on achievement in Mathematics of students at secondary level. As a secondary part of the study, the effectiveness of Kolb’s Experiential Learning Model on mathematics interest and mathematics attitude was also intended to study. The details of the methodology adopted for the study are presented as follows.
4.1 Method Adopted

Since the study was intended to find the effect of Kolb’s Experiential Learning Model on achievement in Mathematics of students at secondary level, **Experimental method** was adopted.

Experimental method is a systematic and logical method of hypothesis testing under carefully controlled conditions. It is the most sophisticated, exact and powerful method for discovering and developing an organized body of knowledge. It is the only type of research that directly attempts to influence a particular variable, and can really test hypothesis about cause and effect relationship. The results of experimental research permit prediction and it provides for much control and therefore establishes a systematic and logical association between manipulated factors and observed effects. Experimental research has repeatedly confirmed, that systematically applied positive reinforcement leads to improved behaviour.

4.1.1 Design Selected

Experimental design attempts to ensure valid casual inferences from randomized experiments conducted within practical constraints of available resources and time. “Experimental design is the blue print of the procedures that enables the researcher to test hypotheses by reaching valid
conclusions about the relationship between independent and dependent variables” (Best & Kahn, 2004).

In the present study, the pre-test – post-test non-equivalent group design was used. Since classroom intact groups were selected for the study to get one to one equalized group for the experimentation is not practically. So the design selected in the present study was pre-test post-test non equivalent group design. One group is usually referred as the experimental group and the other group as the control group. This design is often used in classroom experiments when experimental and control groups are such naturally assembled groups as intact classes, which may be similar (Best & Kahn, 2004).

4.2 Variables in the Study

Something that can change in value and can be measured is a variable. It can be an aspect of an experimental situation or a characteristic that changes in different individuals. For an experimental study, there are independent variables, dependent variables and extraneous variables.

4.2.1 Independent Variables

The variable, which is manipulated by the experimenter or the variable which is suspected of being the cause in the experiment is called independent variable. “It is under the direct control of the experimenter who may vary it in any direction” (Sax, 1979).
In this experiment, the teaching method is the independent variable. The Kolb’s Experiential Learning Model of teaching and the Activity-Oriented Method of teaching are the two independent variables adopted in the study.

4.2.2 Dependent Variables

The dependent variable is the condition or characteristic that appears, disappears or changes as the experimenter introduces, removes or changes independent variable. The dependent variables used in this study are Achievement in Mathematics, Mathematics Interest, Mathematics Attitude and Retention of Achievement in Mathematics.

4.2.3 Extraneous Variables

There is every chance of many extraneous variables to affect the experiment. Among them, learning style, previous achievement, and general mental ability are considered as the major extraneous variables affecting the experiment.

4.3 Population of the Study

The population consists of all the students studying in standard IX in the secondary schools of Kerala.

4.3.1 Sample Selected for the Study

The population consisted of secondary school students of the Government and Aided schools following state syllabus of Kerala.
The investigator decided to adopt purposive random sampling keeping in view the experimental nature of the study and its demands and limitations. Eight IXth standard divisions from four Schools in Kottayam district were selected for the experimentation (Two divisions each from a school). Of the four schools, two are Government schools (Government Higher Secondary School, Arpookara, SKV Government Higher Secondary School, Neendoor) and two are Government Aided schools (M.G.M. High School, Pampady and St. Ephrem's Higher Secondary School, Mannanam).

Out of the selected two divisions of standard IX, from each school, one was taught (experimental group) through the application of Kolb’s Experiential Learning Model of teaching and the other was taught (control group) through the currently following Activity Oriented Method of teaching.

The initial sample consisted of 332 students. By removing absentees in pre-test and post-test, the total number of students included in the study was 326, out of which 163 coming under experimental and 163 under control groups.
Table 4.1
Break-up of Sample for the Study

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of the school</th>
<th>Boys/Girls/Co-edn.</th>
<th>Type of School</th>
<th>No: of students</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Exp. Group</td>
<td>Cont. Group</td>
</tr>
<tr>
<td>1.</td>
<td>S.K.V. G.H.S.S Neendoor</td>
<td>Co-edn.</td>
<td>Govt.</td>
<td>41</td>
<td>39</td>
</tr>
<tr>
<td>2.</td>
<td>St. Ephrem’s. H.S.S. Mannanam</td>
<td>Co-edn.</td>
<td>Aided</td>
<td>45</td>
<td>46</td>
</tr>
<tr>
<td>4.</td>
<td>Government H.S.S Arpookara</td>
<td>Co-edn.</td>
<td>Govt.</td>
<td>33</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>163</td>
<td>163</td>
</tr>
</tbody>
</table>

4.4 Tools Used for the Study

In order to carry out any type of research, data must be gathered and different tools have been developed to aid in the acquisition of data. These tools employ distinctive ways of describing and quantifying the data and are particularly appropriate for certain source of data, yielding information of the kind and in the form that can be most effectively used. The most important tools used in the study are

4.4.1 Lesson Transcripts Based on Kolb’s Experiential Learning Model of teaching (Prepared by the investigator)
4.4.2 Lesson Transcripts Based on Activity Oriented Method of teaching (Prepared by the investigator).

4.4.3 Kolb Learning Style Inventory (Adapted version).

4.4.4 Raven’s Standard Progressive Matrices.

4.4.5 Achievement Test in Mathematics (Prepared by the investigator).

4.4.6 Mathematics Interest Inventory (Prepared by the investigator).

4.4.7 Mathematics Attitude Scale (Prepared by the investigator).

4.4.8 Delayed Memory Achievement test (Prepared by the investigator).

Details regarding each tool is given below

4.4.1 Lesson Transcripts Based on Kolb’s Experiential Learning Model

The lesson units selected for the experiment were subjected to a thorough analysis. Two major units from the text book of standard IX were chosen. The units were Circles – Circumference and Area and Prisms. The concepts to be developed, the principles to be formulated, the procedure adopted for developing rules and equations and the processes leading to problem solving were carefully identified. The following curricular objectives were also identified from these topics.
Unit: Circles – Circumference and Area

The curricular objectives were:-

1. to know the concept of a circle and its circumference
2. to understand that the number obtained by dividing circumference by diameter is a constant for all circles.
3. to understand \(\frac{\text{circumference}}{\text{diameter}}\) is a constant in all circles ie \(\pi\).
4. to understand the circumference of a circle of radius \(r\) is \(2\pi r\).
5. to frame the concept, area of circles.
6. to understand the area of a circle of radius \(r\) is \(\pi r^2\).
7. to frame the concept, arc of circles.
8. to understand different types of arcs of circle.
9. to frame the concept of central angle of an arc.
10. to understand, if the central angle of an arc of a circle of radius \(r\) is \(x^\circ\), then the length of the arc is \(\left(\frac{x}{180}\right)\pi r\).
11. to frame the concept of sector.
12. to understand, if the central angle of the sector of a circle of radius \(r\) is \(x^\circ\), then the area of a sector is \(\left(\frac{x}{360}\right)\pi r^2\).
13. to draw pie charts.
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Unit: Prisms

The curricular objectives were:-

1. to understand the volume of a prism is the product of its base area and height.

2. to understand the lateral surface area of a prism is the product of its base perimeter and height.

3. to understand the surface area of a prism is the sum of the areas of all its faces.

4. to frame the concept of cylinder.

5. to understand the volume of the cylinder is the product of its base area and height.

6. to understand the curved surface area of the cylinder is the product of its base perimeter and height.

7. to understand the surface area of a cylinder of base radius $r$ and height $h$ is $2 \pi r (r + h)$.

In developing the Lesson transcripts the theoretical constructs presented by David A. Kolb and the learning cycle prescribed by the same author was used. The mathematics classes that the investigator taught have a format that avoids the use of large, formal, impersonal, set-piece lectures which concentrate on running through chunks of mathematical theory with the odd
worked example thrown in. Instead, the investigator tries in his classes to encourage the students to undertake experiential learning. Students then have a set of exercises to try on their own and further directed reading through which they gain experience of using the mathematical ideas introduced. At the beginning of the next class there is a brief review of the previous session in which students can feed back their experiences, ask questions, seek clarifications and reflect on their success or otherwise in their attempts to use the material developed in the previous class. This approach follows the classic Kolb’s model of experiential learning (Kolb 1984). From the topics selected for teaching the investigator has located the concepts which could be taught effectively using the Kolb’s Experiential Learning Model.

4.4.1.1 Syntax of Kolb’s Experiential Learning Model

Syntax of the Model describes the main steps of teaching through the model. There are four phases in the Kolb’s Experiential Learning Model. The activities in each phase are as follows.

**Phase I: Concrete Experience**

- Introduction of the concept or problem
- Teacher provides the concrete experience.
- Students form groups based on their learning styles
- Students are actively involved in the process
Phase II: Observation and Reflection

• Students are actively engaged in the experiment.

• Students discuss about the experiment in their learning style groups

• Students analyze the data and form concepts in an organized way.

Phase III: Abstract Conceptualization

• Students inferring and personalizing

• Students form different concepts about the topic.

• Students define concepts themselves

Phase IV: Active Experimentation

• Students realize the importance of the content in their real life.

• Students test the experiment in new situations

• Students identifying life skills

4.4.1.2 Social system

Prior to teaching with the Kolb's experiential learning model, the teacher provide concrete experience to the students. The major functions of the teacher during experiential learning model is to give information knowledge to students and to prescribe study/learning exercises which have “information transmission” as the goal. The system is loosely structured.
4.4.1.3 Principle of reaction

The students are actively involved in the activity. They discuss about that experiment, about their importance, practical applicability and they think reflectively and form abstract concepts about the topic. The teacher simply guide the students in all their activities throughout the class. The teacher should motivate the students to clear their doubts.

4.4.1.4 Support System

In Kolb’s experiential learning model, it requires material for experimentation, math lab equipments etc. The teacher provides the circumstance to conduct the experiment.

4.4.1.5 Instructional / Nurturant Effect

Instructional Effect: At the end, the students will get a clear understanding about the concepts dealt and improve the ability of observation. The student will be able to internalize it in a social and real life situation by organizing content and situation meaningfully.

Nurturant Effect: The student will be able to develop logical reasoning and creativity. This will also help to develop ability to work cooperatively in a group.

4.4.1.6 Validation

The sample lesson transcripts based on Kolb’s Experiential Learning Model was prepared by the investigator following the
procedure for development a lesson transcripts. Then it was given to experts in the field of mathematics teaching and teacher education. The draft transcripts were modified by the investigator based on the feedback and comments received from the experts. Then two lesson transcripts were given for try-out by the investigator to a class of standard IX (another division which is not considered for the experiment) from St. Ephrem’s Higher Secondary School, Mannanam, Kottayam. Then again the lesson transcripts were modified and restructured based on the actual experience the investigator obtained. Thus 16 lesson transcripts were prepared based on the Kolb’s Experiential Learning Model. Sample lesson transcripts (Malayalam version) and its English version are given as Appendices 1 and 2.

4.4.2 Lesson Transcripts Based on Activity Oriented Method

Sixteen lesson transcripts were also prepared based on the Activity Oriented Method, which is currently existing in the schools of Kerala state. The lesson transcripts were prepared keeping in view of the procedure of lesson transcripts development. Sample lesson transcripts based on Activity Oriented Method (Malayalam version) and its English version is given as Appendices 3 and 4.
4.4.3 Learning Style Inventory

The Kolb Learning Style Inventory (KLSI) is designed to understand how one learns best in educational settings and everyday life. It differs from other tests of learning Style and personality used in education by being based on the comprehensive theory of experiential learning. David A. Kolb (1971\textsuperscript{5}, 1984)\textsuperscript{4} published five versions of the Learning Style Inventory over the last four decades.

The investigator adapted the fifth version of the Learning Style Inventory (version 3.1 which was published in 2005\textsuperscript{6}) after minor modifications suited to Indian conditions. The four learning styles described in the Kolb’s learning styles inventory are

1. The Assimilating style: \textit{Combines the Reflective Observation and Conceptualization phases}.

2. The Accommodating style: \textit{Combines the Active Experimentation and Concrete Experience phases}.

3. The Converging style: \textit{Combines the Abstract Conceptualization and Active Experimentation phase}.

4. The Diverging style: \textit{Combines the Concrete Experience and Reflective Observation Phase}. 
The adapted version of the KLSI 3.1 was given to experts for validation. Kolb Learning Style Inventory was a two part questionnaire. KLSI consists of 12 questions about the ways in which one learns best. Each question has four answers, which are to be ranked by an individual in terms of best fit on a scale of $1 - 4$ (4 being best). Responses are organized into two bipolar concepts: Concrete Experience(CE) vs. Reflective Observation(RO) and Abstract Conceptualization(AC) vs. Active Experimentation(AE). The numbers are summarized to give scores for CE, AC, RO, and AE. Then $\text{(AE} - \text{RO})$ and $(\text{AC} - \text{CE})$ are calculated and used abscissa and ordinate, respectively, on a grid that determines one’s ultimate learning styles.
The Kolb learning Style Inventory (adapted version) in Malayalam and its English translation is given as appendices 5 and 6.

4.4.3.1 Administering and Scoring

To determine the learning style, take one’s scores for the learning phases, AC, CE, AE, and RO listed on the second sheet of the questionnaire and subtract as follows to get the two combination scores.

Now mark AC – CE score on the vertical dimension of the Learning Style –Type Grid

Mark AE – RO score on the horizontal dimension. Then place a dot marking the intersections of the two scores on the Grid. The Scoring Key and Learning Style Grid are given as Appendices 7 and 8.

E.g. If AC – CE score is -2 and AE – RO score is +15, the style falls into the Accommodating quadrant.

In the same way learning style quadrants can be identified. The four learning style quadrants are Diverging, Assimilating,
Converging, and Accommodating. A diagrammatic representation of the obtainable four learning style quadrants are given in the following Figure No: 4.2

**Figure 4.2**

**Diagram of four learning style quadrants**

- **Diverging Learning Style quadrant**
- **Assimilating Learning Style quadrant**
- **Converging Learning Style quadrant**
- **Accommodating Learning Style quadrant**

### 4.4.3.2 Reliability and Validity

The reliability of the Kolb Learning Style Inventory was found by test re-test method. The reliability coefficient of AC-CE and AE-RO is 0.71 and 0.78 respectively. This is in conformity with the value obtained at the time of standardization by Kayes (2005) which were 0.77 and 0.84 respectively. This shows that the Adapted version of the Kolb’s Learning Style Inventory has high reliability. Evidence
regarding the validity of an Inventory lies mainly in the procedure
adopted for developing the Inventory. The Kolb Learning Style
Inventory was adapted for our situation very carefully following the
principles of Inventory development. The items in the Inventory are
reworded much carefully, in consultation with experts in the field of
Education. This ensures the validity of the adapted version.

4.4.4 Raven’s Standard Progressive Matrices

Raven’s Progressive Matrices(1938, 2003) are widely used
non-verbal intelligence tests. The Standard Progressive Matrices
(SPM) was designed to measure a person’s ability to form
perceptual relations and to reason by analogy independent of
language and formal schooling, and may be used with persons
ranging in age from 6 years to adult. The matrices measure two
complementary components of general intelligence: the ability to
think clearly and make sense of complex data, which is known as
educative ability; and the ability to store and reproduce
information, known as reproductive ability. It is the first and most
widely used of three instruments known as the Raven’s
Progressive Matrices. Taking into consideration the opinions of the
experts in this field, the investigator decided to use Raven’s
Standard Progressive Matrices to measure the general mental
ability.
4.4.4.1 Scoring: Raven’s Progressive Matrices are multiple choice tests of abstract reasoning. It is published in 1938 as a non-verbal test administered to measure a person’s capacity to apprehend meaningless figures presented for observation, see the relation between them, conceive the nature of the figure completing each system of relations presented and so develop a systematic method of reasoning. The SPM consists of 60 items arranged in five sets (A, B, C, D, & E) of 12 items each. Each item contains a figure with a missing piece. Below the figure are either six (sets A & B) or eight (sets C through E) alternative pieces to complete the figure, only one of which is correct. Each set involves a different principle or "theme" for obtaining the missing piece, and within a set the items are roughly arranged in increasing order of difficulty. All items are presented in black ink on a white background. In each set, the first problem is the easiest one and the consecutive problems became gradually difficult.

4.4.4.2 Reliability: Test-retest correlations range from a low of 0.46 for an eleven-year interval to a high of 0.97 for a two-day interval. The median test-retest value is approximately 0.82. Coefficients close to this median value have been obtained with time intervals of a week to several weeks, with longer intervals associated with smaller values. Raven provided test-retest coefficient for the age group 13 yrs. plus as 0.88
4.4.4.3 Validity: The majority of studies which have factor analyzed the SPM along with other cognitive tests. Concurrent validity coefficients between the SPM and the Stanford-Binet and Weschler scales range between 0.54 and 0.88, with the majority in the 0.70s and 0.80s.

4.4.4.4 Norms: Norm groups included in the manual are: British children between the ages of 6 and 16; Irish children between the ages of 6 and 12; military and civilian subjects between the ages of 20 and 65.

4.4.4.5 Marking Procedure

A student’s score on the scale is the total number of problems solved correctly when allowed to work quickly through the series from the beginning to the end. The total score provides an idea of his intellectual capacity. To record the answers, a record form is available with the Booklets of SPM. The Scoring Key of the Raven’s Standard Progressive Matrices is given as appendix 9.

4.4.5 Achievement Test in Mathematics

Educational achievement in most courses consists of acquiring command of a store of usable knowledge and in developing the ability to perform certain tasks. Knowledge can be categorized as verbal faculty and practical know-how. Abilities usually include anything from ability to explain or ability to take appropriate action in practical situations.
“An achievement test is an instrument designed to measure relative accomplishment in a specified areas of work” (Michaels, 1950). According to Anastasi (1961), the principal object of achievement tests is to appraise the effects of a course of instruction or training.

The investigator developed and standardized an achievement test in mathematics for standard IX keeping in view of the Taxonomy of educational objectives. In the preparation and standardization of the achievement test, the following sequence was adopted.

4.4.5.1 Deciding the Instructional Objectives

Objectives occupy a central position in the teaching – learning programme and hence the determination of objectives and their weightages play a crucial role in any achievement test construction.

A number of educators have devoted considerable effort to reducing ambiguity associated with stating instructional objectives and translating these objectives into relevant test items. The first Taxonomy of educational objectives stemming the work of Benjamin. S. Bloom and others (1956) commonly called “Bloom’s Taxonomy” provides six categories for classifying cognitive behaviours – Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation.
Romberg & Wilson (1969), associates of Bloom developed a model of the objectives for the National Longitudinal Study of Mathematics Abilities (NLSMA) in teaching mathematics. This model was developed by careful study of the Bloom’s Taxonomy of Educational Objectives. The specifications of the cognitive behaviours is similar to that given by Bloom, but modified for categories appropriate to mathematics achievement.

In this study, the objectives of teaching Mathematics in the cognitive domain are taken from the model developed by Romberg and Wilson (1969) for the National Longitudinal Study of Mathematics Abilities (NLSMA). This model is very much useful for evaluating Mathematics achievement in secondary school classroom. The different objectives included in the Cognitive domain in this model are

- Computation
- Comprehension
- Application
- Analysis

**Computation**

Computation level represents the latest complex behaviors which expects from students as out-comes of instruction in mathematics. Computation items are designed to require recall of
basic facts and terminology and the problem elements according to rules the students presumably have learned. Emphasis is up on knowing and performing operations. The computation objective is divided into three subcategories of specific behaviors.

Eg. The multiplication inverse of 5 is

a) -5    b) 1/5    c) -1/5    d) 5    e) don’t know

**Comprehension**

Comprehension is designed to be a more complex set of behaviors than computation. Comprehension relates either to recall of concepts or to transformation of problem elements from one mode to another. The emphasis is on demonstrating understanding of concepts and their relationships. Comprehension objective is divided into six specific behavior categories.

Eg. Which of the following is the measure of an obtuse angle?

a) 45    b) 135    c) 180    d) 225    e) 90

**Application**

Application level items deal with activities that are routine. It require recall of relevant knowledge, selection of appropriate operations and performance of the operations. They require the student to use concepts in a specific context and in a way he has presumably practiced. There are four categories of application identified.
Eg. If X and Y are two distinct real numbers and XZ = YZ,
then Z = ……….  ?

a) 1 / X - Y  b) X - Y  c) 0  d) 1  e) X / Y

**Analysis**

This behavior level is the highest of the cognitive categories – comprising the most complex behaviors. Analysis items require a non-routine application of concepts. This may require the detection of relationships, the findings of patterns, and the organization and use of concepts and operations in a non-practiced context. It includes a greater reliance on heuristic behavior. Five categories of analysis level behaviors are identified.

Eg. If 2a + 2b + 5c = 9 and if c=1, then a + b + c= ---------

a) 2  b) 3  c) 4 ½  d) 5  e) 8

The details regarding the objectives and their specifications are given in Table No. 4.2.
### Table No: 4.2

Objectives with Specification

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Computation</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Knowledge of specific facts</td>
</tr>
<tr>
<td>2.</td>
<td>Knowledge of terminology</td>
</tr>
<tr>
<td>3.</td>
<td>Ability to carry out algorithms</td>
</tr>
<tr>
<td><strong>Comprehension</strong></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Knowledge of concepts</td>
</tr>
<tr>
<td>5.</td>
<td>Knowledge of principles, rules and generalizations</td>
</tr>
<tr>
<td>6.</td>
<td>Knowledge of mathematical structure</td>
</tr>
<tr>
<td>7.</td>
<td>Ability to transfer problem elements from one mode to another</td>
</tr>
<tr>
<td>8.</td>
<td>Ability to follow a line of reasoning</td>
</tr>
<tr>
<td>9.</td>
<td>Ability to read and interpret a mathematical problem</td>
</tr>
<tr>
<td><strong>Application</strong></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Ability to solve routine problems</td>
</tr>
<tr>
<td>11.</td>
<td>The ability to make comparisons</td>
</tr>
<tr>
<td>12.</td>
<td>The ability to analyse data</td>
</tr>
<tr>
<td>13.</td>
<td>The ability to recognize patterns, isomorphism and symmetries</td>
</tr>
<tr>
<td><strong>Analysis</strong></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>The ability to solve non-routine problems</td>
</tr>
<tr>
<td>15.</td>
<td>The ability to discover relationships</td>
</tr>
<tr>
<td>16.</td>
<td>The ability to construct proofs</td>
</tr>
<tr>
<td>17.</td>
<td>The ability to criticize proofs</td>
</tr>
<tr>
<td>18.</td>
<td>The ability to formulate and validate generalizations</td>
</tr>
</tbody>
</table>
4.4.5.2 Mental Processes

While preparing questions for the achievement test, the following mental processes were also given due consideration.

MP_1 retrieves/recollects/retells information.

MP_2 enthusiastically makes connections to new information based on past experiences and formulates initial ideas or concepts.

MP_3 detects similarities and differences.

MP_4 classifies/categories/or organizes information appropriately.

MP_5 translates/transfers knowledge or understanding and applies them in new situations.

MP_6 establishes cause-effect relationships.

MP_7 makes connections/relates prior knowledge to new information/applies reasoning and draw inferences.

MP_8 Communicates knowledge/understanding through different media

MP_9 imagines/fantasies/designs/predicts based on received information.

MP_10 judges/appraises/evaluates the merits or demerits of an idea/develops own solutions to a problem.
4.4.5.3 Selection of Content subunits

Two major topics, Circle – Circumference and Area and Prisms from the Mathematics curriculum of standard IX were selected. They were divided into five teaching sub-units as given below.

Sub-unit 1: Circumference and Area of Circles
Sub-unit 2: Arcs and their Lengths.
Sub-unit 3: Sectors
Sub-unit 4: Prisms - Volume and Area
Sub-unit 5: Cylinders

4.4.5.4 Type of Questions

Along with the fixing up of objectives, the type of question to be included in the draft test was determined. Keeping in view of the judged superiority of objective type items, the investigator decided to construct an objective type achievement test. The highly regarded and widely used form of objective tests is multiple-choice type which is the most flexible and most effective item type.

According to Ebel and Frisbie (1991),14 “Multiple choice items are adaptable to the measurement of most important educational outcomes of knowledge, understanding and judgment of ability to solve problems, to recommend appropriate action, to
make predictions”. Keeping this in view, the investigator selected objective type multiple-choice test items only.

4.4.5.5 Preparation of Draft Test

The test construction demanded vast experiences in the field. Therefore with the support and help of experts and experienced teachers in the field, the investigator was able to prepare the achievement test with multiple-choice items in the content area selected. A draft test consisting of 45 multiple-choice items was prepared with necessary directions on the first page. The items were arranged according to their increasing order of difficulty. Most of the items were intended for average students, but neither the gifted nor the dull was ignored. A copy of the draft test (Malayalam version) and its English version is provided as Appendices 10 and 11. The Scoring Key of the draft test is also provided as appendix 12a and its response sheet as 12b.

4.4.5.6 Try Out

The try out of the draft test for item analysis was conducted on a sample of 370 students of standard X selected by random sampling procedure. Prior arrangements were made with the authorities for the proper conduct of the test, under satisfactory examination conditions. Test was conducted in June 2009 in all the institutions under identical conditions, especially regarding the instructions given to the examinees. Enough time was given
so as to enable all the students to complete the test. The scoring was done according to the scoring key prepared for this purpose. Sample split up for the try out is given in table 4.3

### Table No: 4.3

**Break-up of Sample for the Try Out**

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Name of the school</th>
<th>Boys/Girls/Co-edn</th>
<th>Type of School</th>
<th>No: of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>St. Thomas H.S. Kallara</td>
<td>Co-edn</td>
<td>Aided</td>
<td>45</td>
</tr>
<tr>
<td>2.</td>
<td>Infant Jesus H.S Manarcad</td>
<td>Girls</td>
<td>Aided</td>
<td>46</td>
</tr>
<tr>
<td>3.</td>
<td>Holy Family H.S S Kottayam</td>
<td>Co-edn</td>
<td>Aided</td>
<td>45</td>
</tr>
<tr>
<td>4.</td>
<td>Govt. H.S.S Pampady</td>
<td>Co-edn</td>
<td>Govt.</td>
<td>24</td>
</tr>
<tr>
<td>5.</td>
<td>Govt. G.H.S. Ettumannoor</td>
<td>Girls</td>
<td>Govt.</td>
<td>25</td>
</tr>
<tr>
<td>6.</td>
<td>D.V H.S.S Kumaranalloor</td>
<td>Co-edn</td>
<td>Aided</td>
<td>42</td>
</tr>
<tr>
<td>7.</td>
<td>Emmanual H.S.S Kothanallor</td>
<td>Co-edn</td>
<td>Aided</td>
<td>47</td>
</tr>
<tr>
<td>8.</td>
<td>Govt.Boys H.S.S Ettumanoor</td>
<td>Boys</td>
<td>Govt.</td>
<td>26</td>
</tr>
<tr>
<td>10.</td>
<td>Govt. Model G.H.S Thiruvalla</td>
<td>Girls</td>
<td>Govt.</td>
<td>23</td>
</tr>
</tbody>
</table>

### 4.4.5.7 Item Analysis

It is the process of establishing the suitability of an item for inclusion in the final test. The quality of each item was ascertained
by analyzing two important characteristics of the item, namely 1) Difficulty Index and 2) Discriminating Power.

From the obtained 370 answer scripts, complete in all respects were finally selected for analysis. Based on the scores obtained, response sheets of the students were arranged in descending order from highest to the lowest. The responses of the top scoring 27 percent and the bottom scoring 27 percent were used for item analysis. For the present study the procedure and formula suggested by Ebel and Frisbie (1991) were used to calculate the difficulty index and discriminating power.

\[
\text{Index of item difficulty } \quad DI = \frac{U + L}{2N}
\]

\[
\text{Index of discriminating power } \quad DP = \frac{U - L}{N}
\]

where,

U = Number of correct responses in the upper group

L = Number of correct responses in the lower group

N = Number of pupils in each group

In the present study, items having difficulty index between 0.35 and 0.65 and discriminating power above 0.3 are also considered in order to have sufficient number of test items in the final form of the test. Out of the 45 items, 25 were selected for the final test. The details regarding the difficulty index and discriminating power are given as appendix 13.
4.4.5.8 Preparation of the Final Test

The final test was prepared by giving due weightage to content, objectives, difficulty level, type of questions and through distracter analysis.

**Weightage to Content subunits**

The content is a means to obtain the ends – the objectives. The relative weightage for each content unit was taken in consultation with experienced teachers.

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Unit</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Circumference and area of circles</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>2.</td>
<td>Arcs and arc lengths</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>3.</td>
<td>Sectors</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>4.</td>
<td>Prisms-area and volume</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>5.</td>
<td>Cylinders</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

**Weightage to Instructional Objectives**

Once the objectives were determined, the next task was to assign weightages to these objectives. All objectives may not receive equal importance in any instruction. The relative weightages for each objective was given in consultation with experienced teachers.
Table No.: 4.5

Weightage to Instructional 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>Computation</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>Comprehension</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>3</td>
<td>Application</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>4</td>
<td>Analysis</td>
<td>7</td>
<td>28</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Weightage to Difficulty Level

The investigator was given due weightage to the difficulty level of the test items. Majority of items in the test are average difficulty type. There are items which are easy as well as difficult.

Table No.: 4.6

Weightage to Difficulty Level

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Difficulty Level</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Easy</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>2.</td>
<td>Average</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>3.</td>
<td>Difficult</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Distracter Analysis

If the distracters are properly given, guessing can be eliminated. Since the test consists of multiple-choice items, a distracter analysis was also done to eliminate guessing.

Blue Print

The investigator prepared a blue print before preparing the final test. The blue print given in table no. 4.7.
### Table No.: 4.7

**Blueprint**

<table>
<thead>
<tr>
<th>No. of qn.</th>
<th>Content</th>
<th>Comprehension</th>
<th>Application</th>
<th>Analysis</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Circumference and area of circles</td>
<td>1</td>
<td>(2)</td>
<td>(1)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Arcs and Arc lengths</td>
<td>(1)</td>
<td>(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sectors</td>
<td>1</td>
<td>(2)</td>
<td>(1)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Prisms-Area and Volume</td>
<td>1</td>
<td>(2)</td>
<td>(1)</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Cylinders</td>
<td>1</td>
<td>(3)</td>
<td>(1)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td>4</td>
<td>8</td>
<td>7</td>
<td>25</td>
</tr>
</tbody>
</table>
Out of the 45 items included in the draft test, after try-out 25 items were selected for the final test, based on difficulty index and discriminating power of items as in the blueprint. The time duration of the test was decided to be 40 minutes. The copy of achievement test in the final form and its English version is given as appendices 14 and 15. The scoring key of the final form of the test is given as appendix 16a and its response sheet as 16b.

**4.4.5.9 Reliability**

The reliability of the test was established by using split-half method. A sample of 100 pupils studying in standard IX was used for this purpose. Here, the odd numbered items were treated as one half of the test and scored separately and all the even numbered items were treated as another half and scored for each examinee. The scores of the halves were correlated and the reliability of the test was found to be 0.8124.

Making questions based upon pre-determined specific behaviors, ensuring that the expected answers are definite and objective, providing clearly spelt-out scheme for scoring and conducting test under identical and ideal examination conditions helped in enhancing reliability of the test.

**4.4.5.10 Validity**

The validity of a test may be defined as the accuracy with which it is intended to measure. There are different types of
validity, but as far as an achievement test is concerned content validity and empirical or statistical validity are important.

**Content Validity**

Before the construction of the test, a thorough analysis of the curricular objectives was done with the help of standard textbooks. The test was constructed keeping in view the weightage given for content area with instructional objectives on one hand and experts’ comments and opinions on the other. So it can be treated as a valid test.

**Empirical or Statistical Validity**

The empirical validity of the test was calculated by correlating the scores of the test with marks of a recently conducted test obtained from the school. The co-efficient of correlation obtained was 0.8453. This value ensures the empirical validity of the test.

**4.4.5.11 Objectivity and Practicability**

In the prepared achievement test, objectivity was ensured by including only objective type items and by using scoring key for valuation. The test was easy to administer as it was in the booklet form and necessary directions to complete test is given in the front sheet of the booklet itself. It was economical, as it was reusable, since the answer sheets were provided separately. The time fixed for the test is 40 minutes which is convenient. Time needed for
scoring was minimum as the window stencil method was adopted. Hence, the test had good practicality

4.4.6. Mathematics Interest Inventory

According to Crow and Crow (1973), "Interest may refer to the motivating force that impels us to attend to a person, a thing or an activity or may be the effective experience that has been stimulated by the activity itself. In other words, interest can be the cause of an activity and the result of participation in that activity". Interest influences learning through its direction of our attention, its encouragement of specific learning strategies, and its effect on our emotional engagement. Because of the integral role of interest in learning, the ability to measure this construct effectively is of particular importance not only to continued research but also to practical situations. Educators who can measure students' levels of interest in mathematics will gain valuable information concerning how to educationally program for an individual student and what interventions might be necessary to encourage the student's interest.

Mitchell (1993) noted that a major weakness of interest research was the small number of interest measures available. Although this weakness has been addressed to some degree, a continued need exists to develop measures that assist in evaluating interest across specific domains. In this study the
investigator developed a mathematical interest inventory to measure the student’s mathematical interest. Instruments and Procedure items for the Mathematics Interest Inventory were developed based on a current literature review of both situational and individual interest. Items were also created considering language and behaviors relevant to high school students.

Mathematics Interest Inventory is used to measure the academic interest of students in Mathematics. It is a five-point scale. Here the investigator prepared a Mathematics Interest Inventory based on the general aspect of mathematical interest.

4.4.6.1 Description of the Interest Inventory

As a preliminary step, the item for the draft interest inventory was prepared after a thorough review of relevant literature and also with the advice of experts in the field. After discussions with experts in the field of Mathematics and Education, 50 statements were prepared and it was again given to another group of experts for comments and suggestions. As per the comments and suggestions received, some of the statements were deleted and others were modified. Thus the edited draft Mathematics Interest Inventory consists of 50 items. Each item is to measure the interest of students in Mathematics. These 50 statements are arranged randomly.
In the instruction part itself, the 5 responses are given as

(A) less interested
(B) little interested
(C) moderately interested
(D) more interested
(E) most interested

Corresponding to each statement, the space is given to write the responses regarding the mathematical interest as (A) or (B) or (C) or (D) or (E). The Malayalam and English versions of the draft interest inventory are given as appendices 17 and 18.

**Table No.: 4.8**

Scores given to various response of the Mathematics Interest Inventory

<table>
<thead>
<tr>
<th>Responses</th>
<th>Response Letter</th>
<th>Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>less interested</td>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>little interested</td>
<td>B</td>
<td>2</td>
</tr>
<tr>
<td>moderately interested</td>
<td>C</td>
<td>3</td>
</tr>
<tr>
<td>more interested</td>
<td>D</td>
<td>4</td>
</tr>
<tr>
<td>most interested</td>
<td>E</td>
<td>5</td>
</tr>
</tbody>
</table>

4.4.6.2 Procedure for administering and scoring of the draft mathematics interest inventory

The draft scale of Mathematics Interest Inventory was a self-administering one. Instruction to the students was given in the
draft inventory. The inventory was administered to 150 students studying in standard IX in the schools mentioned in table no. 4.9 in June 2009. The test forms were given to the students and they were asked to write alphabets corresponding to each item in the appropriate space provided. After collecting back the test booklets, the scoring was made. The scores to the responses for statements are as shown in Table No.4.8. The scores of all the items were summated to obtain the mathematics interest inventory score of an individual.

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Name of the School</th>
<th>Type of management</th>
<th>No.of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Govt.Boys.H.S.Ettumanoor</td>
<td>Govt.</td>
<td>21</td>
</tr>
<tr>
<td>2</td>
<td>Govt.Girls H.S.Ettumanoor</td>
<td>Govt.</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>Govt. H.S. Pampady</td>
<td>Govt.</td>
<td>22</td>
</tr>
<tr>
<td>4</td>
<td>St.Thomas H.S.Kallara</td>
<td>Aided</td>
<td>43</td>
</tr>
<tr>
<td>5</td>
<td>Emmanual H.S.Kothanalloor</td>
<td>Aided</td>
<td>44</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>150</td>
</tr>
</tbody>
</table>

**4.4.6.3 Item Analysis**

It is the process of establishing the suitability of an item for inclusion in the final inventory. The quality of each item was ascertained by analyzing the important characteristic of the item,
namely the Discriminating Power. After item analysis 30 items were selected for the final form of Mathematics Interest Inventory. The response sheets of 150 students were arranged in descending order of total scores. The response sheets of highest 27 percent and lowest 27 percent (40 each) used as extreme groups for item analysis. According to Ebel (1996), \(^{17}\) “27 percent provides the best compromise between two desirable and inconsistent aims to make extreme groups as large as possible to make extreme groups as different as possible”. The scores obtained for each item in these extreme groups were used for calculating the discriminating power of each item. The discriminating power was obtained by calculating the critical ratio ‘t’ using the formula

\[
t = \frac{X_H - X_L}{\sqrt{\left(\frac{\sigma_H^2}{N_1} + \frac{\sigma_L^2}{N_2}\right)}}
\]

Edwards(1957)\(^{18}\)

Where,

\(X_H\) = the mean score of upper group for a given statement

\(X_L\) = the mean score of lower group for a given statement

\(N_1\) = number of students in the upper group

\(N_2\) = number of students in the lower group

\(\sigma_H\) = standard deviation of the upper group for a given statement

\(\sigma_L\) = standard deviation of the upper group for a given statement
4.4.6.4 Preparation of final Mathematics Interest Inventory

For the preparation of final interest inventory, the items having ‘t’ value equal or above 1.75 were selected, as the ‘t’ value is a measure of the extend to which a given statement differentiates between the high and low groups. Edwards(1957)\(^{18}\) opined that “as a crude and approximate rule of thumb, we may regard any ‘t’ value equal to or greater than 1.75 as indicating that the average response of the high and low groups to a statement differs significantly, provided we have 25 or more subjects in the high group and also in the low group”. After computing the ‘t’ value, the best 30 items were selected. Hence the final form of the Mathematics Interest Inventory with 30 items was prepared. The final form of Mathematics Interest Inventory (Malayalam version) and its English version are given as appendices 20 and 21. The ‘t’ value for each statement are also given as appendix 19.

4.4.6.5 Reliability and Validity

The reliability of the mathematics Interest Inventory was found by using split-half method. The reliability coefficient of the Interest Inventory was found to be 0.89. This shows that the Mathematics Interest Inventory has high reliability. Evidence regarding the validity of an Interest Inventory lies mainly in the procedure adopted for developing the Inventory. The Mathematics Interest Inventory was prepared very carefully following the principles of Inventory
development. The item selection procedure was a clear indication of the internal validity. The face validity of the Interest Inventory was ascertained by giving the inventory to experts for their comments. The teachers were also requested to rate the pupils according to their interest in Mathematics on a five-point scale. Then using the rating and scores obtained by using Interest Inventory were correlated and it was found to be 0.801. This shows that the mathematics Interest Inventory has high empirical validity.

4.4.7. Mathematical Attitude Scale

The term attitude refers to a learned predisposition to react consistently in a given manner to certain persons, objects or concepts. Attitudes are positive or negative feelings that an individual hold about objects, persons or ideas and are generally regarded as enduring through modifiable by experience. In the absence of appropriate scale for measuring the mathematics attitude of students, the investigator decided to construct a mathematics attitude scale for the research work. The Mathematics Attitude Scale is a device used to measure the attitude towards Mathematics of standard IX students. The scale was prepared following the Likert method and is a five – point scale. Here the investigator prepared a draft Mathematics Attitude Scale based on the general attitude of students towards Mathematics. This draft scale contains 50 items; which is sufficient to produce a valuable measure of attitude towards
mathematics. The scale is designed to produce quantifiable data that may be subjected to statistical analysis to draw inferences.

4.4.7.1 Description of the Attitude Scale

As a preliminary step, the item for the draft attitude scale was prepared after a thorough review of relevant literature and also with the advice of experts in the field. After discussions with experts in the field of Mathematics and Education, 50 statements both positive and negative were prepared and it was again given to another group of experts for criticisms and suggestions. As per the criticisms and suggestions received, some of the statements were deleted and others were modified. Thus the edited draft Mathematical Attitude Scale consists of 50 items. Out of which 25 are positive statements and 25 are negative statements. Each item is to measure the attitude of students towards Mathematics. These 50 statements are arranged randomly. Care was taken to give sufficient space against the appropriate statements for entering the response in the scale itself. The 5 responses of agreements or disagreements are given as

1. Strongly Agree (SA)
2. Agree (A)
3. Undecided (U)
4. Disagree (DA)
5. Strongly Disagree (SD)
Methodology

Corresponding to each statement, the columns are given to mark the responses regarding the attitude towards mathematics using a tick (✓) mark.

Table No.: 4.10
Scores given to various response on the Mathematics Attitude Scale

<table>
<thead>
<tr>
<th>Responses</th>
<th>Scores for positive statements</th>
<th>Scores for negative statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Agree</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Undecided</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Disagree</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

4.4.7.2 Procedure for administering and scoring of the draft scale

The draft scale of Mathematics Attitude was a self-administering one. Instruction to the students was given in the draft scale. The scale was administered to 150 students studying in standard IX in the schools (mentioned in table No.4.11) in June 2009. The test forms were given to the students and they were asked to make a tick mark (✓) on each item in the appropriate space provided. After collecting back the test booklets, the scoring was made. The scores to the responses for positive and negative statements are as shown in the Table No. 4.10. The scores of all the items were summated to obtain the mathematics attitude.
score of an individual. The Malayalam and English versions of the draft scale are given as appendices 22 and 23.

**Table No.: 4.11**

**Distribution of the sample for try-out of Mathematics Attitude Scale**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Name of the School</th>
<th>Type of management</th>
<th>No.of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Govt.Boys.H.S.Ettumanoor</td>
<td>Govt.</td>
<td>21</td>
</tr>
<tr>
<td>2.</td>
<td>Govt.Girls H.S.Ettumanoor</td>
<td>Govt.</td>
<td>20</td>
</tr>
<tr>
<td>3.</td>
<td>Govt. H.S. Pampady</td>
<td>Govt.</td>
<td>22</td>
</tr>
<tr>
<td>4.</td>
<td>St.Thomas H.S.Kallara</td>
<td>Aided</td>
<td>43</td>
</tr>
<tr>
<td>5.</td>
<td>Emmanual H.S.Kothanalloor</td>
<td>Aided</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>150</strong></td>
</tr>
</tbody>
</table>

**4.4.7.3 Item Analysis**

Item analysis was done to select suitable items for the final attitude scale. The response sheets of 150 students were arranged in descending order of total scores. The response sheets of highest 27 percent and lowest 27 percent (40 each) used as extreme groups for item analysis. The scores obtained for each item in these extreme groups were used for calculating the discriminating power of each item. The discriminating power was obtained by calculating the critical ratio ‘t’ using the formula
\[ t = \frac{X_H - X_L}{\sqrt{\left(\frac{\sigma_H^2}{N_1} + \frac{\sigma_L^2}{N_2}\right)}} \]

Edwards(1957)\(^{18}\)

Where,

- \(X_H\) = the mean score of upper group for a given statement
- \(X_L\) = the mean score of lower group for a given statement
- \(N_1\) = number of students in the upper group
- \(N_2\) = number of students in the lower group
- \(\sigma_H\) = standard deviation of the upper group for a given statement
- \(\sigma_L\) = standard deviation of the upper group for a given statement

4.4.7.4 Preparation of final Mathematics Attitude Scale

For the preparation of final attitude scale, the items having ‘t’ value equal or above 1.75 were selected, as the ‘t’ value is a measure of the extend to which a given statement differentiates between the high and low groups. After computing the ‘t’ value the best 35 items were selected. Hence the final form of the Mathematics Attitude Scale with 35 items was prepared. Of which 18 items are positive statements and the remaining 17 items are negative. The final form of Mathematics attitude Scale (Malayalam version) and its English version are given as appendices 25 and 26. The ‘t’ value for each statement are also given as appendix 24.
4.4.7.5 Reliability and Validity

The reliability of the mathematical Attitude Scale was found by using split-half method. The reliability coefficient of the Attitude Scale was found to be 0.816. This shows that the mathematics attitude scale has high reliability. Evidence regarding the validity of an attitude scale lies mainly in the procedure adopted for developing the scale. The Mathematics attitude scale was prepared very carefully following the principles of attitude scale construction (Likert, 1932; Thurstone and Chave, 1929; Edwards, 1957). The item selection procedure was a clear indication of the internal validity. The face validity of the attitude scale was ascertained by giving the scale to experts for their assessment. The teachers were also requested to rate the pupils according to their attitude towards Mathematics on a five-point scale. Then using the rating and scores obtained by using attitude scale were correlated and it was found to be 0.73. This shows that the attitude scale has high empirical validity.

4.4.8 Delayed Memory Achievement Test in Mathematics

A delayed memory achievement test helps to find out the retention capacity of the subjects of study. For the present study, a delayed memory achievement test was prepared to find out retention capacity of experimental and control groups. The delayed memory achievement test prepared is almost similar to that of the
achievement test in mathematics. The delayed memory achievement test is constructed with same weightage to content, objectives and difficulty level to that of the achievement test. But the measurements, situations, order and warding of questions are different. The construction also followed the same procedure. The delayed memory achievement test in mathematics (Malayalam version) and its English version is given as Appendices 27 and 28. The scoring key of the delayed memory test is given as Appendix 29a and its response sheet as 29b.

4.5 Procedure Adopted in Experimentation

The experiment was conducted to study the effectiveness of Kolb’s Experiential Learning Model on achievement in Mathematics of students at secondary level. For that the investigator developed and standardized the tools.

After finalizing the sample and tools to be used, the investigator approached the authorities of the schools and sought their permission for conducting the study. The investigator met the heads of the schools and class teachers and had discussions with them and their co-operation was ensured. Permission from PTA was also secured through the heads of the respective institutions.

The Raven’s Standard Progressive Matrices was administered to compare their general mental ability of the students. Then the
learning styles of students were identified by using the Kolb learning style inventory.

Before starting the experiment, the investigator compared the previous achievement in mathematics of the experimental and control groups. Then the Achievement Test, Mathematics Interest Inventory, Mathematical Attitude Scale were administered as pre-tests in both the experimental and control groups. A short explanation of the aim and scope of the study was given to the students and their co-operation was ensured. The rules and procedure prescribed for each type of test were strictly followed. The response sheets were collected back after the allotted time and were scored.

Then the investigator conducted classes based on Kolb’s Experiential Learning Model in the experimental group and classes based on Activity Oriented Method in the control group. 16 lesson transcripts in each method were prepared and used. Each lesson transcript was taught in period of 40 minutes duration. The investigator divided the experimental group based on their Learning Styles namely Converging, Diverging, Assimilating or Accommodating for varied treatments. Learning style wise groups were identified in the control group also. But during classroom transaction, random grouping procedure was adopted. The same topics were taught in both the groups.
After the completion of experiment, the mathematics achievement test, mathematics interest inventory and mathematics attitude scale were administered again as post-tests to both the groups. The scores were then analyzed statistically. After one month from the completion of the experiment, a delayed memory achievement test in mathematics was also administered.

4.6 Scoring Procedure

The data regarding previous achievement and general mental ability were scored and compared. The data with regard to learning style were also scored to identify the learning style groups.

Four tests were given as post-tests to the students namely Achievement Test in Mathematics, Mathematics Interest Inventory, Mathematical Attitude Scale and Delayed Memory Achievement test. In the Achievement Test, 25 multiple choice questions were used. Four alternatives were given for each question. Out of which one is correct or best. For each correct answer 1 mark is given and zero for incorrect answers. The maximum mark for the test was 25.

The Mathematical Interest Inventory was a five point rating scale. In addition to the instruction on the inventory, the investigator gave clarifications during the administration of the inventory. The five point rating scale has five responses such as less interested, little interested, moderately interested, more
interested and most interested and 1, 2,3,4,5 marks respectively were awarded to these responses.

The mathematical Attitude Scale was also a five point scale. The five responses on the scale were Strongly Agree(SA), Agree (A), Undecided (U), Disagree (D), Strongly Disagree(SD) and marks 1,2,3,4,5 were given respectively to the responses on negative statements and 5,4,3,2,1, were given respectively to the responses on positive statements.

In delayed memory achievement Test, 25 multiple choice questions were used. Four alternatives were given for each question. Out of which one is correct or best. For each correct answer 1 mark is given and zero for incorrect answers. The maximum mark for the test was 25.

4.7 Statistical Techniques Used for Analysis

The pre-test and post-test scores of the experimental group and control group were consolidated for statistical analysis. The mean and standard deviation of the scores for each pre-test were found out and ensured the equivalence of the two groups by adopting critical ratio test. A preliminary analysis was done using the method of critical ratio and test of significance to compare the performance of experimental and control groups.
The experiments were done using intact, previously known parallel classroom groups. Analysis of Co-variance is a method that enables the researcher to equate the pre-experimental status of the groups in terms of relevant known variables. Difference in the initial status of the group can be removed statistically so that they can be compared as though their initial status had been equated. (Best; 2004). Thus in the present study, the following major statistical techniques were used:

1. Skewness
2. Kurtosis
3. Critical ratio (t-test)
4. ANOVA
5. ANCOVA

The details of analysis of data using the relevant statistical techniques have been compiled in the next chapter.
References


