METHODOLOGY

Variables of the Study
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CHAPTER IV
METHODOLOGY

This chapter gives an outline of the entire research plan of the study intended to find the effectiveness of Advance Organizer Model in the teaching of Mathematics among Secondary School Pupils at differing levels of intelligence. In order to attack the problem, an experimental study was designed. The objectives of the study, and the hypotheses formulated in tune with objectives, are stated in Chapter I.

4.1 VARIABLES OF THE STUDY

4.1.1 Independent Variables

The study as indicated earlier was mainly intended to find the effectiveness of Advance Organizer Model in the teaching of Mathematics among Secondary School Pupils at differing levels of intelligence. As such the independent variables happened to be

1. Advance Organizer Model and
2. Conventional Method of teaching

4.1.2 Dependent Variables

The dependent variables are the scores in Mathematics achievement, which are attributable to the influence of Advance Organizer Model and Conventional Method of teaching. In the present study the investigator takes special interest in the influence of Advance Organizer Model in creating Instructional and Nurturant effects of the model. Hence the other dependent variables in the present study are the scores obtained in the test constructed by the investigator to measure

1. Conceptual Structure
2. Meaningful Assimilation of Information and ideas
3. Interest in Inquiry
4. Habit of Precise Thinking
### Methodology

#### 4.1.3 Confounding Variables

The most salient feature of the experiment is the control of the experiment is the control of variables that might influence the dependent variables. The scholastic attainment of a student in a particular content depends on intelligence, proficiency level of that subject in general and the pre requisite that are essential for mastering the new content.

#### 4.1.4 Intervening Variables

Some psychological factors like anxiety, fatigue and motivation is likely to affect dependent variables.

#### 4.1.5 Extraneous Variables

Achievement is also affected by variables like age, sex, locale of students, teacher factor, time of the day and length of instruction.

The control variable considered for the present study were intelligence, general proficiency of students in Mathematics, pre requisite needed for mastery of the new topics to be learned, age, sex, locale and teacher factor. In addition to all these factors, time of day and treatment length in time were equated. Among these the significant controlling variables of the study, General Mathematical Proficiency of students and attainment of Prerequisite needed for mastery of the new topics to be learnt are expressed by means of some achievement scores.

Majority of the reported research studies empirically verified, established a very high positive relationship between intelligence and achievement. The other two significant controlling variables for the present study the general mathematical proficiency and the attainment of the pre requisite needed for mastering the new topic is highly correlated with intelligence. Also, it is to be noted that, “Matching is a technique for equating groups on one or more variables the researcher identified on being highly related to performance in the dependent variables (Gay, 1990). But matching on the basis of many variables is ordinarily not worthwhile since the matching
variables should be uncorrelated (Guilford, 1965). Regarding these aspects in the present study, intelligence was taken as the only matching variable.

Having fixed the variables of the study, the investigator formulated an appropriate design to conduct the study, details of which are described in the following sections.

4.2 DESIGN OF THE STUDY

In the present study, the investigator decided to conduct an experimental research in which the experiment involves a comparison of effectiveness of AOM of teaching with that of Conventional Method of teaching among Secondary School Pupils at differing levels of intelligence. An experimental study of this type is normally conducted with respect to experimental and control groups that are equated for relevant related variables. As such Advance Organizer Model is introduced in experimental group and the control group is allowed to carry on the Conventional Method of teaching. Choice of the treatment to the groups was determined randomly.

As stated earlier Intelligence was considered as the most important matching variable in view of the fact that the high positive relationship between scholastic achievement and intelligence. But in normal school setting it was impractical to set up group in which subjects have been matched person for person and hence investigator resorted to the technique of “matching of groups in terms of Mean and SD (Garret, 1981). At the same time, care was taken to see that the two groups were comparably equal with regard to General Mathematics Proficiency score and prerequisite scores since the achievement of students in a particular curricular content depend on these variables also. In order to further substantiate the result of comparison, age, sex and locale of the students included in the two groups were equated.

For the present study, pretest was not desirable because the exposure of the subject through the pretest may influence learning experience and might influence the post test. Hence the study was decided to be conducted by post test only equivalent group design (Best, 1992).
After conducting the experiment in accordance with the particular design the difference between the means of post test scores and relevant scores of both groups were subjected to a test of statistical significance as proposed by Best and Garrett (Best, 1992; Garrett 1981).

After fixing the design, for the success of conducting the experiment the investigator decided to select an adequate and appropriate sample. The detailed design of the sample is given in the next section.

### 4.3 SAMPLE

This section is devoted mainly for the purpose of describing in detail each of the following aspects. Selection of the class, Selection of the units, Selection of the school and the two groups – the experimental and control groups under investigation.

#### 4.3.1 Selection of the Class

The investigator selected standard VIII, as the class to conduct the study. This was done so because pupils of standard VIII, belonging to 12+ age group which come under the formal operational stage (11-15) according to the classification of Piaget. The pupils at this stage can logically solve all types of problems, think systematically, solve complex verbal and hypothetical problems and their cognitive structure are mature (Wadsworth, 1989).

According to the curriculum also, study of Mathematics with a theoretical bend starts from Standard VIII onwards. The children in the 12+ age group are in the beginning of secondary school stage. Therefore if any difference is found to exist with regard to their cognitive structure there will be enough time to fill up the gap before the completion of secondary stage. Hence the investigator felt that the teaching strategy can be experimented meaningfully within the long period of one complete academic year to a set of pupils belonging to that developmental stage.

#### 4.3.2 Selection of the Units

After deciding the class upon which the study is to be conducted, the Mathematics text book prescribed for standard VIII was thoroughly analyzed.
STRUCTURING CONTENT

After determining the background of the learners, the goals for the lesson, unit or course have been identified. As the next step for planning, investigator structured the content in a systematic way. Some topics were already hierarchically organized into super ordinate and subordinate concepts lend themselves naturally to this type of organization. On the other hand there were many situations in which the investigator had to impose structure on previously unstructured material. In the absence of unifying themes, this was done in several ways. One way was to arbitrarily impose a structure on the content using best judgment. The organization of this content allows students to see the relationship. Another way of organization was to use interrelated generalization. A third way of organizing a large body of content for an Interactive lesson was through the use of an extended analogy. The use of an analogy allowed students to relate the new knowledge they are learning to schemata already acquired.

Content organization should be based primarily upon the internal logic of the content itself. Ultimate care was taken so that subordinate concepts are subsumed by super ordinate concepts, and thus inclusive generalization is related to those narrower and less inclusive. Cognitive structure of each individual is also a major factor. In organizing the topic, the developing schema is anchored to subsuming generalization, definition, or analogy, which serves as an Advance Organizer.

A summary of the major content is listed below.

1. **Sets – Basic Concepts – Set Operation**

   1.1 Sets as a well defined collection- members of sets- members need not be always concrete objects.- Abstract ideas and symbols as members of set

   1.2 Representation of sets

      1.2.1 Roster form

      1.2.2 Statement form or set builder form
1.2.3 Naming of set
1.2.4 Need for two forms and limitations
1.3 Elements of a set
1.3.1 Symbol for representing “is an element of” and “is not an element of” a set
1.4 Number of elements in a set
1.4.1 Cases where a member is repeated – symbol for noting the number of elements of a set
1.4.2 Cardinality
1.4.3 Different kinds of a set based on the number of elements. Finite set and infinite sets – singleton set and null set – symbol for null set
1.5 Idea of subset, superset, and their symbols
1.5.1 Idea of proper subsets – Null set as a sub set of every set – every set is as subset of itself
1.5.2 Total number of subsets of a finite sets
1.6 Equivalent and equal sets
1.7 Use of Venn diagrams to illustrate sets and subsets
1.8 Universal set as a super set of sets under reference
1.9 Set operations
1.9.1 Intersection and its symbol – representation using Venn diagrams – Idea of Disjoint sets
1.9.2 Union and its symbol – representation using Venn diagram
1.9.3 Complementation and its symbol – representation using Venn diagram
1.10 Simple practical problems involving set operations

2. **Formation of some Geometric Principles**

2.1 Experimental verification of the following principles:
2.1.1 Base angles of an isosceles triangles are equal and its converse

2.1.2 In a triangle, the sum of any two sides is greater than third side

2.1.3 In a triangle, the longest side is the one that is opposite to the largest side

2.1.4 The exterior angle of a triangle is equal to the sum of the remote interior angles

2.1.5 The angles of an equilateral triangle are equal

2.1.5.1 The line segment joining the midpoints of any two sides of a triangle is half the third side

2.1.6 The sum of the four angles of a quadrilateral is $360^0$

2.1.7 The opposite sides of a parallelogram are equal

2.1.8 The opposite angles of a parallelogram are equal

2.1.9 The diagonals of a parallelogram bisect each other

2.1.10 The sum of the angles of a polygon of ‘n’ sides is $(2n-4)$ Rt.

Angles

2.1.11 The angle in a semicircle is a right angle

2.1.12 The opposite angles of a cyclic quadrilateral are supplementary

2.1.13 The perpendicular from the center of a circle to a chord bisects the chord

2.1.14 Equal chords of a circle are equidistant from the center

3. **Algebra**

3.1 Multiplication of a polynomial by a monomial

3.2 Division of a polynomial by a monomial

3.3 Multiplication of a binomial by another binomial

3.4 Identities

3.4.1 Open sentences and closed sentences
3.4.2 Domain of a variable – solution set – Always true sentence – Identities

3.5 Expansion using \(a(b+c) = ab + ac\)

3.6 Expansion using \(k(a+b+c) = ka+kb+kc\)

3.7 Expansion using \((a+b)^2 = a^2 + 2ab + b^2\)

3.8 Expansion using \((a-b)^2 = a^2 - 2ab + b^2\)

3.9 Expansion using \((a+b)(a-b) = a^2 - b^2\)

3.10 Expansion using \((x+a)(x+b) = x^2 + (a+b)x + ab\)

3.11 Application of identities in multiplication of numbers

3.12 Factorization using \(a(b+c) = ab + ac\) and \(k(a+b+c) = ka+kb+kc\)

3.13 Factorization using \((a+b)^2 = a^2 + 2ab + b^2\)

3.14 Factorization using \((a-b)^2 = a^2 - 2ab + b^2\)

3.15 Factorization using \((a+b)(a-b) = a^2 - b^2\)

3.16 Factorization using \((x+a)(x+b) = x^2 + (a+b)x + ab\)

3.17 Application of factorization using these identities in numerical calculations.

4. **Mensuration of Plane Figures**

4.1 Perimeter of a triangle

4.2 Area of a triangle using the formula \(A = \frac{1}{2}bh\) and \(A = s(s-a)(s-b)(s-c)\)

4.3 Area of an equilateral triangle \(A = \sqrt{\frac{3}{4}a^2}\)

4.4 Area of parallelogram \(A = bh\)

4.5 Area of trapezium \(A = \frac{1}{2} h (l_1 + l_2)\)

4.6 Area of rhombus \(A = d_1d_2/2\)

4.7 Area of a quadrilateral by the method of triangulation

4.8 Area of regular hexagon \(A = \sqrt{6 \cdot 3a^2/4}\)

4.9 Field book and other practical applications

4.10 Concept of circumference of a circle
4.11 Concept of $\pi$ and its historical background – approximate value taken as 3.14

4.12 Calculation using the formula $C = 2\pi$ or $\pi d$

4.13 Area of a circle using the formula $A = \pi r^2$

4.14 Idea of circular paths and calculation of its area $A = \pi (R^2 - r^2)$

4.15 Length of arc of a sector $l = \frac{X \cdot 2 \pi r}{360}$

4.16 Area of sector $A = \frac{X \pi r^2}{360}$

4.17 Area of combination of plane figures

5. **Simple Equation**

5.1 Ideas of equation: simple equation

5.2 Idea of truth set/Solution set of an equation

5.3 Idea of equivalent equation

5.4 Solution of simple equation

5.5 Framing simple equation from verbal statements

5.6 Solving problems involving simple equation

6. **Statistics**

6.1 Significance of statistics in day to day life

6.2 Condensing information in the form of tables

6.3 Classification of raw data and preparation of frequency table

6.4 Concepts and conventions associated with frequency table, size or width of the class upper limit and lower limit of a class- mid value of a class frequency of a class etc.

6.5 Construction of Histogram and simple interpretations

This content analysis helped the investigator to hierarchically structure the content so that it can be subjected to progressive differentiation and thus the content matter can be effectively subsumed to the intellectual scaffold of the learner using integrative reconciliation. The investigator felt that the
principles of Advance Organizer Model can be effectively presented in these topics. Experts in Mathematics Education were also consulted in fixing the topics. Having fixed the topics the next task of the investigator was to select a school for the purpose of the investigation.

4.3.3 Selection of the School

Two equated groups of students of standard VIII had to be selected for conducting the study as envisaged by the investigator. It was decided that the sample could be selected from only one school to meet the ends of the investigation. Although with a large sample, it would be possible to minimize the errors of sampling. As the experiments last for one complete academic year, it was thought that selection of large sample was both impracticable and undesirable.

For this it was decided to select one school having sufficient number of students of standard VIII i.e. more than 30 members in each group and so that it would be a handy sample at the same time large enough.

The study was conducted in Government High School, Marayoor, Idukki District. The investigator was a High School Teacher of Government High School Marayoor, at the time of investigation. The present study was a long term study which extends for a whole year to complete the data collection. Moreover the authorities of the school were cooperative and ready to provide complete help at any time to conduct the experiment under ideal conditions. Investigator ensured that students selected for investigation are with homogeneous abilities between the groups and heterogeneous abilities within the group.

4.3.4 Selection of the Groups

The selection of two groups for experimentation was based on the technique of matching i.e. Sampling is restricted by matching (Guilford, 1965). Experimental and control groups were equated with respect to major relevant related variables that might affect achievement.
Even though, matching may be done ‘by pairs’ or ‘by total group’ (Guilford, 1965), in a normal classroom setting the technique of ‘equivalent group – matching by pairs’ was not followed due to some practical difficulties. The investigator made use of a technique of, Matching for total groups by ensuring that Mean and SD of the variable are practically the same for both the groups.

Two groups, which were not differing significantly with respect to Mean and SD with respect to Intelligence score, General Mathematical Proficiency Score and Prerequisite score, were selected for the study.

Each group had about 40 students and all of them were included in the experiment. They had to take few tests – intelligence test, prerequisite test post test immediately after the experiment and also after three weeks. All these students could not attend all classes and tests. So all of them could not be considered for final analysis. Only 32 students could attend all tests in one division. For convenience, the same number of students was considered in the other division also for final analysis. The pupil who could not fall in the group were also allowed to sit in the class and they were equally treated, but were unaware of the grouping.

For the purpose of investigation the investigator employed few tools which are described below.

### 4.4 TOOLS EMPLOYED

Wherever standardized tools were not available, the investigator developed tools having psychomotor properties with the help of her supervising teacher and expert opinion. The following tools were employed for collection of data:

- b. Pre requisite test (Prepared by the investigator)
- c. Achievement Test (Prepared by the investigator)
d. Test to measure the instructional effects – Cognitive structures and Meaningful Assimilation of Information (Prepared by the investigator)

e. Test to measure the Nurturant effects- Interest in Inquiry and Habit of Precise Thinking (Prepared by the investigator)

**4.4.1 Kerala Non-verbal Group Test of Intelligence for Secondary School Pupils (Nair, 1969).**

This is a standardised Non-verbal Group Test of Intelligence. It is a popular tool used for the appraisal of general intelligence of secondary school pupils of Kerala. The scale provides a single score for general intelligence, measured by adding the scores in the four subtests.

The battery consists of four subtests: Figure Classification, Figure Series, Figure Analysis and Figure Matrices. The details of the tests components, number of items in each subtests, testing time, etc. are given in Table 4.1.

**Table 4.1**

Test Components and Other Details of the Kerala Non-verbal Group Test of Intelligence

<table>
<thead>
<tr>
<th>Subtest Number</th>
<th>Test Component</th>
<th>Number of Items including Practice Items</th>
<th>Time Limit in Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Figure Classification</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>II</td>
<td>Figure Series</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>III</td>
<td>Figure Analogies</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>IV</td>
<td>Figure Matrices</td>
<td>20</td>
<td>5</td>
</tr>
</tbody>
</table>

**Description of Subtests**

*Figure Classification*

This consists of five figures, four of which can be grouped together according to some law or principle, while one of them will not fit in
with the remaining figures of the group. The subject has to identify the figures which will not go with the group. This subtest measures the ability to perceive relationship. An illustrative item is presented below.

A  B     C      D      E

Correct Answer- D

There are 20 items of this kind, out of which only 16 are used for scoring. The first four items are given below (along with the answers) as practice items. The subject has to work out the sixteen items within the specified time limit of 5 minutes. One score is given for each correct response.

**Figure Series**

Each item of this subtest consists of 5 small squares arranged in a row. Four squares contain certain abstract figures while the last square is empty. The subject has to find out the figure which when placed in the empty square will complete the design or (complete the series). Four alternative answers are supplied. The subject has to choose one from this. The figures in the design follow a certain law. Looking at the first four figures, the subject has to find out what would follow, as the fifth figure (fifth item) of the given series. An illustrative item is presented below.

Answer

A  B     C      D

Correct Answer-B

There are sixteen items to be answered in 5 minutes. One score is given for each correct response.
**Figure Analogies**

In each item of this subtext, there are 4 squares in a row, grouped into two sections. The two squares of the first section and the first square in the second section contain certain abstract shape, whereas the last square is blank. The squares are spaced into two groups – the first two on the left and the other two on the right. The figures contained in the first pairs on the left implies a relationship. The same relationship is assumed to hold for the pair of squares on the right as well. Applying the relationship connecting the figures in the first two squares, the subject has to visualise that the figure which when put in the blank square on the right would imply the same relationship. The subject has to select the answer from a set of 4 alternatives given below.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Figure Analogies Example" /></td>
<td>A B C D</td>
</tr>
</tbody>
</table>

Correct Answer – D

There are sixteen items to be answered in 5 minutes. One score is given for each correct response.

**Figure Matrices**

There are 9 squares arranged in the form of 4 rows and 3 columns in each test. The matrix of 9 squares with the figure inside put together form a design. The bottom, right hand square is vacant while the other squares contain certain abstract figures. The subject is asked to examine the squares in each row (each columns) and find out the principles (relationship) connecting the figures in the first and second rows and use the common principle to find the figure that has to come in the blank square of the 3\textsuperscript{rd} column (row). A set of 4 alternatives are given as answers. The subject has to choose the right answer from the 4 alternatives. An illustrative item is given below.
There are sixteen items in the subtest to be answered in 5 minutes. One score is given to each correct response.

**Scoring**

The test is scored by assigning one score for each correct answer. Separate total, for each subtest can be obtained and then the scores on the 4 subtests are combined to yield the total score for non-verbal intelligence.

**Validity and Reliability of the Test Battery**

**Validity**

The validity of the test has been assessed using different test as external criteria (Nair, 1971).

Validity coefficient using Progressive Matrices Test (PMT) as external criteria $r = 0.784$ (N = 256), with Kerala Verbal Group Test of Intelligence as external criteria $r = 0.52$ (N = 504), and with total marks in S.S.L.C. Examination $r = 0.537$ (N = 324). Factor analysis of the battery with the Progressive Matrices Test and Kerala Verbal Group Test of Intelligence as reference test revealed the presence of a major general factor of intelligence in all the test of the battery.

**Reliability**

Test-retest reliability of the test has been calculated with different intervals between testing. For three months interval, reliability = 0.76 (N = 246); one month interval between tests, reliability = 0.75 (N = 124) and for one week interval between tests $r = 0.8$ (N = 121).
Corrected split-half coefficients for the whole test battery and for the component tests \((N = 237)\) are given in Table 4.2.

**Table 4.2**

Split-half Reliability Coefficient of the Kerala Non-verbal Group Test of Intelligence

<table>
<thead>
<tr>
<th>Number</th>
<th>Subtest</th>
<th>Correct Value of reliability Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Figure Classification</td>
<td>0.92</td>
</tr>
<tr>
<td>2.</td>
<td>Figure Series</td>
<td>0.90</td>
</tr>
<tr>
<td>3.</td>
<td>Figure Analogies</td>
<td>0.88</td>
</tr>
<tr>
<td>4.</td>
<td>Figure matrices</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>Whole Test</td>
<td>0.91</td>
</tr>
</tbody>
</table>

Reliability estimated by the rational equivalence method was 0.864 \((N = 100)\).

The values quoted above shows that the test is a reliable and valid instrument for measuring the general factor of intelligence. It could therefore be treated as an appropriate tool for the purpose of investigation.

### 4.4.2 Lesson Transcript according to Advance Organizer Model

Consulting with experts, and a thorough analysis of the topics of standard VIII lesson transcript of AOM were prepared by the investigator, following the systematic steps as envisaged by Joyce and Weil (1992) and Passi, Sansanwal and Singh. (1988). The Advance Organizer Model has three phases of activity, Phase one is the presentation of the Advance Organizer, phase two is the presentation of learning material and phase three is the strengthening of the cognitive organization.

As a first step while preparing the lesson plan format educational objectives are to be identified in behavioural terms. In phase one-Presentation of the Advance Organizer the following steps are great important. Accordingly following aspects have been identified and included in and considered while developing lesson transcripts.
The theoretical constructs for Advance Organizer has already been explained in chapter two. While preparing the lesson transcripts, all principles enumerated there have been taken care of as can be seen as from the following description of the procedure adopted.

The six steps to be considered for selecting appropriate Advance Organizer for each subunit, (Passi, 1988) were taken care of for this task. Thus to start with the goal of the lesson was operationally stated. The material was presented in a well organized fashion. Steps were taken to ensure integrative reconciliation. Active reception learning was promoted in each stage. Steps have been suggested in the transcripts to elicit critical approach to subject matter. Previous information was used to clarify the new concept introduced.

The investigator has to identify most appropriate AO to be used and also determine the way in which chosen AO is used to make verbal learning meaningful. In order to give a very exact picture of what has been proposed in the lesson transcripts a detailed content analysis was done in this regard and it is consolidated and recorded in the following table.

**Table 4.3**

**Detailed Analysis of Content**

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Unit / Subunit</th>
<th>Main teaching point</th>
<th>Concepts/ Generalization / Analogy</th>
<th>Comparative /Expository</th>
<th>Title/ Generalizing/ Statement/ Summarizing points/defining objectives/asking statements about related topics</th>
<th>Advance Organizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>SET</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Introduction</td>
<td>Set as a well defined collection Members of a set</td>
<td>Concept</td>
<td>Expository</td>
<td>Title</td>
<td>Collection</td>
</tr>
<tr>
<td>1.2</td>
<td>Representation of set</td>
<td>Statement form Roster method Rule method</td>
<td>Concept</td>
<td>Expository</td>
<td>Statement</td>
<td>Set</td>
</tr>
<tr>
<td>1.3</td>
<td>Elements of set</td>
<td>Elements of set Symbols</td>
<td>Concept</td>
<td>Comparative and</td>
<td>Asking about students related</td>
<td>Set</td>
</tr>
<tr>
<td>Cardinality</td>
<td>1.4</td>
<td>Single set</td>
<td>Null set</td>
<td>Finite set</td>
<td>Infinite set</td>
<td>of set</td>
</tr>
<tr>
<td>-------------</td>
<td>-----</td>
<td>------------</td>
<td>----------</td>
<td>------------</td>
<td>--------------</td>
<td>--------</td>
</tr>
<tr>
<td>1.5</td>
<td>Subset Superset</td>
<td>Elements of subset</td>
<td>Symbols of subset</td>
<td>Elements of subset</td>
<td>Cardinality</td>
<td>Concept</td>
</tr>
<tr>
<td>1.6</td>
<td>Properties of subset and superset</td>
<td>Properties of subset</td>
<td>Elements of subset</td>
<td>Number of elements in the finite subset</td>
<td>Concept</td>
<td>Generalizing</td>
</tr>
<tr>
<td>1.7</td>
<td>Equal set Equivalent set</td>
<td>Properties of Equal set</td>
<td>Elements</td>
<td>Number of elements</td>
<td>Concept</td>
<td>Comparative and Expository</td>
</tr>
<tr>
<td>1.8</td>
<td>Venn diagram Universal Set</td>
<td>Pictorial Representation of set</td>
<td>Elements</td>
<td>Number of elements</td>
<td>Concept</td>
<td>Comparative and Expository</td>
</tr>
<tr>
<td>1.9</td>
<td>Set operation Intersection</td>
<td>Properties of set</td>
<td>Elements/not Elements of, Related Symbols</td>
<td>Concept</td>
<td>Comparative and Expository</td>
<td>Asking students about related concepts</td>
</tr>
<tr>
<td>1.10</td>
<td>Set operation Union</td>
<td>Properties of set</td>
<td>Elements/not Elements of, Related Symbols</td>
<td>Concept</td>
<td>Comparative and Expository</td>
<td>Asking students about related concepts</td>
</tr>
</tbody>
</table>
## 1. Methodology

<table>
<thead>
<tr>
<th>1.11</th>
<th>Set operation</th>
<th>Properties</th>
<th>Concept</th>
<th>Comparative and Expository</th>
<th>Asking students about related concepts</th>
<th>Defining</th>
<th>Summarizing point</th>
<th>Generalizing</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Differenc e</td>
<td>Elements/not Elements of, Related Symbols</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.12</td>
<td>Disjoint Set</td>
<td>Disjoint set</td>
<td>Concept</td>
<td>Comparative and Expository</td>
<td>Asking students about related concepts</td>
<td>Defining</td>
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<td>Complimentary Sets</td>
<td>Properties</td>
<td>Concept</td>
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<td>Elements/not Elements of, Related Symbols</td>
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<td>1.14</td>
<td>Formula related to cardinality of sets after set operation</td>
<td>Properties</td>
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<td>Comparative and Expository</td>
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#### 2. FORMATION OF GEOMETRIC PRINCIPLES

<table>
<thead>
<tr>
<th>2.1</th>
<th>Isosceles triangle theorem</th>
<th>Isosceles triangle, properties, Base angles of an isosceles triangle are equal</th>
<th>Concept</th>
<th>Generalizing</th>
<th>Comparative and Expository</th>
<th>Asking students about related concepts</th>
<th>Defining</th>
<th>Summarizing points and Generalizing</th>
<th>Triangle</th>
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<tbody>
<tr>
<td>2.2</td>
<td>Relationship Between length of sides of triangle</td>
<td>In a triangle the sum of any two sides is greater than the third side</td>
<td>Generalizing</td>
<td>Comparative and Expository</td>
<td>Asking students about related concepts</td>
<td>Defining</td>
<td>Summarizing points and Generalizing</td>
<td>Different types of triangle</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Length of sides</td>
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<tr>
<td>2.3</td>
<td>Relationship Between angles and sides of triangle</td>
<td>In a triangle longest side is the one opposite to the largest angle</td>
<td>Generalizing</td>
<td>Comparative and Expository</td>
<td>Asking students about related concepts</td>
<td>Defining</td>
<td>Summarizing points and Generalizing</td>
<td>Different types of triangle</td>
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<td></td>
<td>Measure of angles and Length of sides</td>
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<tr>
<td>2.4</td>
<td>Angle sum</td>
<td>Sum of the measures of</td>
<td>Generalizing</td>
<td>Generalizing</td>
<td>Asking students about related concepts</td>
<td>Defining</td>
<td>Summarizing points and Generalizing</td>
<td>Different types of triangle</td>
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<td>Table Entry</td>
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<td>Level</td>
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<td>2.5</td>
<td>Exterior angle Theory of a triangle</td>
<td>Generalizing</td>
<td>Measure of exterior angle is equal to sum of measure of remote interior angle</td>
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<tr>
<td>2.6</td>
<td>Relationship of length of side and line joining the midpoint of the other two sides</td>
<td>Generalizing</td>
<td>The line joining the midpoints of any two sides of a triangle is half the third side</td>
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<td>2.7</td>
<td>Angle sum property of quadrilateral</td>
<td>Generalizing</td>
<td>Sum of the measures of the interior angle of a quadrilateral is 360 degree</td>
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<tr>
<td>2.8</td>
<td>Theory relating to parallelogram</td>
<td>Generalizing</td>
<td>Opposite sides of a parallelogram are of equal measures, Opposite angles of a parallelogram are of equal measures, Diagonal of a parallelogram are of equal measures</td>
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<tr>
<td>2.9</td>
<td>Angle sum property of polygon</td>
<td>Generalizing</td>
<td>If a polygon has n sides the sum of measures of all the interior angle is 2n-4 right triangle</td>
<td></td>
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<td>2.10</td>
<td>Theorems related to circles</td>
<td>Generalizing</td>
<td>Angle in a semi circle is right angle</td>
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</tr>
<tr>
<td>2.11</td>
<td>Cyclic quadrilateral</td>
<td>Generalizing</td>
<td>Opposite angles of a circle</td>
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</tr>
</tbody>
</table>

**Measure of angles**

**Triangle**

**Quadrilateral**

**Parallelogram**

**Polygon**

**Circle**
<p>| 2.12 | Theorem s related to circle | cyclic quadrilateral are supplementary | Generalizing | Comparative | concepts Summarizing points and Generalizing | Quadrilateral |
| 2.13 | Theorem s related to circle | Perpendicular from centre of a circle to a chord bisects the chord | Generalizing | Comparative | Asking students about related concepts Summarizing points and Generalizing | Circle |
| 3.1 | Multiplication of a polynomial by a monomial | terms obtained by multiplying a polynomial by a monomial | Generalizing | comparative and Expository | Asking students about related concepts Summarizing points and Generalising | Polynomial Operation of real number |
| 3.2 | Multiplication of binomial by another binomial | terms obtained by dividing a polynomial by a monomial | Generalizing | Comparative and Expository | Asking students about related concepts Summarizing points and Generalising | Polynomial Operation of real number |
| 3.3 | Open sentence Closed sentence | terms obtained by multiplying a binomial by another binomial | Generalizing | Comparative and Expository | Asking students about related concepts Summarizing points and Generalising | Linguistic sentences phrase and terms |
| 3.4 | Solution set | domain solution set symbolic representation | Generalizing | Comparative and Expository | Asking students about related concepts Summarizing points and Defining concepts | Sentence Domain |</p>
<table>
<thead>
<tr>
<th>3.5</th>
<th>Methodology</th>
<th>Always true sentence</th>
<th>Concept</th>
<th>Comparative and Expository</th>
<th>Asking students about related concepts</th>
<th>Summarizing points and generalizing</th>
<th>Sentence Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6</td>
<td>Identities</td>
<td>$a(b+c)=ab+ac$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts</td>
<td>Summarizing points and generalizing</td>
<td>Multiplication of a monomial by a binomial</td>
</tr>
<tr>
<td>3.7</td>
<td>Identities</td>
<td>$k(a+b+c)=ka+kb+kc$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts</td>
<td>Summarizing points and generalizing</td>
<td>Multiplication of monomial by a polynomial</td>
</tr>
<tr>
<td>3.8</td>
<td>Identities</td>
<td>$(a+b)^2=a^2+2ab+b^2$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts</td>
<td>Summarizing points and generalizing</td>
<td>Multiplication of a binomial by a binomial</td>
</tr>
<tr>
<td>3.9</td>
<td>Identities</td>
<td>$(a-b)^2=a^2-2ab+b^2$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts</td>
<td>Summarizing points and generalizing</td>
<td>Multiplication of a binomial by a binomial</td>
</tr>
<tr>
<td>3.10</td>
<td>Identities</td>
<td>$(a+b)(a-b)=a^2-b^2$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts</td>
<td>Summarizing points and generalizing</td>
<td>Multiplication of a binomial by a binomial</td>
</tr>
<tr>
<td>3.11</td>
<td>Identities</td>
<td>$(x+a)(x+b)=x^2+x(a+b)+ab$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts</td>
<td>Summarizing points and generalizing</td>
<td>Multiplication of a binomial by a binomial</td>
</tr>
<tr>
<td>3.7</td>
<td>Identities</td>
<td>$(a+b)(c+d)=ac+ad+bc+bd$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts</td>
<td>Summarizing points and generalizing</td>
<td>Multiplication of a binomial by a binomial</td>
</tr>
<tr>
<td>3.8</td>
<td>Factorization</td>
<td>$ab+ac=2(b+c)$ Factors are $a$ and $b+c$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts</td>
<td>Summarizing points and generalizing</td>
<td>Factors of real numbers, Identity $a(b+c)=ab+ac$</td>
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</table>
### Methodology

<table>
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<tr>
<th>3.9</th>
<th>Factorization</th>
<th>$ka+kb+kc = k(a+b+c)$</th>
<th>Generalizing</th>
<th>Comparative</th>
<th>Asking students about related concepts. Summarizing points and generalizing</th>
<th>Factors of real numbers, Identity $k(a+b+c)=ka+kb+kc$</th>
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</thead>
<tbody>
<tr>
<td>3.10</td>
<td>Factorization</td>
<td>$a^2+2ab+b^2 = (a+b)(a+b)$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and generalizing</td>
<td>Factors of real numbers, Identity $(a+b)^2=a^2+2ab+b^2$</td>
</tr>
<tr>
<td>3.11</td>
<td>Factorization</td>
<td>$a^2-2ab+b^2 = (a-b)(a-b)$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and generalizing</td>
<td>Factors of real numbers, Identity $(a-b)^2=a^2-2ab+b^2$</td>
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<td>3.12</td>
<td>Factorization</td>
<td>$a^2-b^2 = (a+b)(a-b)$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and generalizing</td>
<td>Factors of real numbers, Identity $(a+b)(a-b)=a^2-b^2$</td>
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<tr>
<td>3.13</td>
<td>Factorization</td>
<td>$x^2+x(a+b)+ab = (x+a)(x+b)$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and generalizing</td>
<td>Factors of real numbers, Identity $(x+a)(x+b)=x^2+x(a+b)+ab$</td>
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<tr>
<td>3.14</td>
<td>Factorization</td>
<td>$ac+ad+bc+bd = (a+b)(c+d)$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and generalizing</td>
<td>Factors of real numbers, Identity $(a+b)(c+d)=ac+ad+bc+bd$</td>
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#### 4. MENSURATION OF PLANE FIGURES

<table>
<thead>
<tr>
<th>4.1</th>
<th>Concept of area</th>
<th>$A=\frac{1}{2}bh$</th>
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<th>Comparative</th>
<th>Asking students about related concepts. Summarizing points and arriving at a formula</th>
<th>Area of rectangle</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2</td>
<td>Area of right triangle</td>
<td>$A=\frac{1}{2}bh$</td>
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<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and arriving at a formula</td>
<td>Area of right triangle</td>
</tr>
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<td>$A = \frac{1}{2}bh$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and arriving at a formula</td>
<td>Area of right triangle</td>
</tr>
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</tr>
<tr>
<td>4.4</td>
<td>Area of equilateral triangle</td>
<td>$A = \frac{\sqrt{3}}{4}a^2$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and arriving at a formula</td>
<td>Hero's formula</td>
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<tr>
<td>4.5</td>
<td>Area of regular hexagon</td>
<td>$A = 6 \times \frac{\sqrt{3}}{4} a^2$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and arriving at a formula</td>
<td>Area of equilateral triangle</td>
</tr>
<tr>
<td>4.6</td>
<td>Area of parallelogram</td>
<td>$A = bh$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and arriving at a formula</td>
<td>Area of rectangle</td>
</tr>
<tr>
<td>4.7</td>
<td>Area of Trapezium</td>
<td>$A = \frac{1}{2}h(a+b)$</td>
<td>Generalizing</td>
<td>Comparative</td>
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</tr>
<tr>
<td>4.8</td>
<td>Area of rhombus</td>
<td>$A = \frac{1}{2}d_1d_2$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and arriving at a formula</td>
<td>Area of Triangle</td>
</tr>
<tr>
<td>4.9</td>
<td>Area of quadrilateral</td>
<td>$A = \frac{1}{2}d_1h_1 + d_2h_2$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and arriving at a formula</td>
<td>Area of Triangle</td>
</tr>
<tr>
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<td>Area of plots</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and arriving at a formula</td>
<td>Area of Triangle</td>
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### Methodology

<table>
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<tr>
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<th>Circle</th>
<th>Circumference</th>
<th>Generalizing</th>
<th>Comparative</th>
<th>Asking students about related concepts. Summarizing points and arriving at a formula</th>
<th>perimeter of rectangle</th>
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</thead>
<tbody>
<tr>
<td>4.12</td>
<td>Area of circle</td>
<td>$A = \pi r^2$</td>
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<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and arriving at a formula</td>
<td>Area of Rectangle</td>
</tr>
<tr>
<td>4.13</td>
<td>Area of circular ring</td>
<td>$A = \pi (R^2 - r^2)$</td>
<td>Generalizing</td>
<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and arriving at a formula</td>
<td>Area of circle</td>
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</table>

### 5. SIMPLE EQUATION

<table>
<thead>
<tr>
<th>5.1</th>
<th>Simple equation</th>
<th>Variable, phrase, sentence, equation, simple equation, degree of variable, degree of equation</th>
<th>Concept</th>
<th>Comparative</th>
<th>Asking students about related concepts. Summarizing points and arriving at a definition</th>
<th>Equation</th>
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<tbody>
<tr>
<td>5.2</td>
<td>Truth set</td>
<td>True sentence/ false sentence</td>
<td>Concept</td>
<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and arriving at a generalization</td>
<td>Linguistic sentence Set</td>
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<td>5.3</td>
<td>Equivalent equation</td>
<td>Formation of equivalent equation-different approaches</td>
<td>Concept</td>
<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and arriving at a definition</td>
<td>Equation Solution set</td>
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<td>5.4</td>
<td>Solution of simple equation</td>
<td>Process of finding solution of simple equation</td>
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<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and arriving at a generalization</td>
<td>Truth set</td>
</tr>
<tr>
<td>5.5</td>
<td>Framing simple equation</td>
<td>Translation of verbal statement into analogy</td>
<td>Analogy</td>
<td>Comparative</td>
<td>Asking students about related concepts. Summarizing points and arriving at a generalization</td>
<td>Verbal statement</td>
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</table>
### 6. Statistics

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Conceptual Approach</th>
<th>Mathematical Representation</th>
<th>Verbal Statement</th>
<th>Truth Set</th>
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<tbody>
<tr>
<td>6.1</td>
<td>Tabular Form</td>
<td>Concept</td>
<td>Comparative</td>
<td>Verbal statement</td>
<td>Mathematical representation</td>
</tr>
<tr>
<td>6.2</td>
<td>Frequency Distribution Table</td>
<td>Ordering</td>
<td>Comparative Expository</td>
<td>Verbal statement</td>
<td>Mathematical representation</td>
</tr>
<tr>
<td>6.3</td>
<td>Graphical Representation</td>
<td>Analogy</td>
<td>Comparative Expository</td>
<td>Verbal statement</td>
<td>Mathematical representation</td>
</tr>
</tbody>
</table>

#### 4.4.3 Pre-Requisite Test

For learning a new task certain pre-requisites are to be mastered. Hence assessing the previous knowledge of the learner regarding the new content to be learned is very important. Apart from the conventional method of assessing previous knowledge by asking for a show of hands if learner think they know the concept, asking learner to list, group and label things related to concept and asking students to explain the concepts, the most effective method is applying a diagnostic pre test.

The development of a prerequisite test was planned in terms of related principles formulated by the educators. Based on this steps were taken and a
pre diagnostic test was developed to determine what students know about the new content.

The topics of Standard VIII, namely Sets, Formation of Geometric Principles, Algebra, Mensuration of Plane Figures, Simple Equation and Statistics, which were intended to be handled was subjected to a thorough analysis and the prerequisites that are essentially needed for learning each of the new learning points were determined. The main prerequisites are the following.

1. **Sets**
   1.1 Collection of things, objects
   1.2 List objects with same characteristics
   1.3 Ordering of objects
   1.4 Counting numbers – Smallest counting number, Concept of largest counting number
   1.5 Whole numbers –concept of smallest and largest number
   1.6 Concept of positive and negative numbers
   1.7 Representing numbers on a number line
   1.8 Concept of odd and even numbers
   1.9 Concept of zero

2. **Formation of Geometric principles**
   2.1 Concept of Angles
   2.2 Concept of different types of triangles
   2.3 Concept of different types of quadrilaterals
   2.4 Concept of diagonal
   2.5 Concept of perpendicular line segment
   2.6 Concept of circle and chords

3. **Algebra**
   3.1 Concept of Monomial, Binomial, Polynomial
   3.2 Concept of Algebraic sentence
   3.3 Concept of operation –addition, subtraction, multiplication and division of numbers
Methodology

3.4 Concept of equations
3.5 Concept of inequality
3.6 Factorization of numbers
3.7 Concept of Factors

4. Mensuration of plane figures
   4.1 Concept of different Triangles
   4.2 Concept of different quadrilaterals
   4.3 Concept of diagonals
   4.4 Concept of circles
   4.5 Perimeter of rectangle
   4.6 Area of rectangle

5. Simple Equation
   5.1 Concept of algebraic sentences
   5.2 Substituting values for the variables in an algebraic sentence
   5.3 Concept of closed and open sentence
   5.4 Guessing a solution for a simple equation

6. Statistics
   6.1 Concept of raw data
   6.2 Graphical representation of data through line graph and bar graph
   6.3 Concept of frequency table.

The results of this analysis were scrutinized by a team of subject experts and necessary modification were made. Based on this the items to test the prerequisite were developed by the investigator. Again this was scrutinized by expert teachers. The qualitative item analysis was done by through analysis and screening by subject experts. Content validity was expected to be satisfactory and as such no further steps was taken for quantitative item analysis. The final prerequisite test thus prepared by the investigator contained 25 objective type test item for each unit. The prerequisite tests are given as appendix.
4.4.4 Achievement Test

To measure the most important dependent variable of the study namely, Mathematics achievement of the students, an Achievement Test had to be prepared and standardized by the investigator with the help of supervising teacher. This has been done systematically.

Planning of Achievement test

A thorough analysis of the Mathematics textbook of Standard VIII – Kerala State syllabus, with reference to selected topics, Set, Formation of Geometric Principle, Algebra, Mensuration of Plane Figures, Simple Equation and Statistics was made. For convenience, Achievement test was divided into six separate sections based on the selected topics. The test covered questions coming under the major objectives, Knowledge, comprehension, application, analysis, synthesis, evaluation and skill. A design and blue print for the final tests were developed giving weightage to all items usually considered.

The weightage given to the different objectives in the achievement test in different content is listed below.

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Total</th>
<th>%</th>
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<tbody>
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<td>Knowledge</td>
<td>19</td>
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<tr>
<td>Comprehension</td>
<td>23</td>
<td>16</td>
</tr>
<tr>
<td>Application</td>
<td>26</td>
<td>18</td>
</tr>
<tr>
<td>Analysis</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td>Synthesis</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td>Evaluation</td>
<td>17</td>
<td>12</td>
</tr>
<tr>
<td>Skill</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>144</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Preparation of Blue Print

The blue print, which is essential to good test construction, was assembled before actually beginning the unit so that it is useful in planning and organizing instruction as suggested by Tom Kubiszyn (990). It was decided to frame the items in the Achievement test as multiple-choice items with five options each. As regard weightage, Mehran and Lehmann (1973), clearly stated that there is no hard and fast rule that can be prescribed for the teacher to use in determining the weightage to be assigned to various cells in the blue print. Experience is his best source. Hence, after consulting with experts due weightage was given to each component and a blue print was prepared and it is given below.

Table 4.5
Blue print for the Achievement Test

<table>
<thead>
<tr>
<th>Chapter Objectives</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td>Comprehension</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>23</td>
<td>16</td>
</tr>
<tr>
<td>Application</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td>26</td>
<td>18</td>
</tr>
<tr>
<td>Analysis</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td>Synthesis</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td>Evaluation</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>17</td>
<td>12</td>
</tr>
<tr>
<td>Skill</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>144</td>
<td>100</td>
</tr>
</tbody>
</table>

After deciding the frame for the items to be tested, the next issue is to describe the procedure in brief about how the items were selected.

Selection of test item

To include items in the test, the textbook was very thoroughly and minutely analyzed. As, Multiple-choice items enable to measure higher levels of the Taxonomy of Educational Objectives at the same time ensures all the good qualities of objective type test item, it was decided to prepare the
items as multiple-choice items. While preparing the items following principles were taken care of.

1. The stem of the item was constructed clearly to formulate the problem. As much of the item as possible was included, keeping the response options as short as possible.

2. Items were constructed to include one and only one correct best answer for each question.

3. The distracters were made plausible. Length and form of all answer choice were kept equal.

4. Negative questions or statements were used only for the cases where the knowledge being tested requires it.

5. Five options were included for each question.

6. The difficulty of a multiple choice item was increased by increasing the similarity of the options

There is no rule that can be adopted about the minimum number of items that should be used for the test to be valid. It can vary according to the purpose. Since the test was used for measuring the various level of cognition and also for covering six different areas of content, 24 items were included in each unit thus covering 144 items in total.

A draft question paper consisting of sufficiently large number of multiple-choice items based on the selected six units were prepared. Majority of the items was intended for the average students, but neither the intelligent nor the dull are ignored. Items written were given to experts for getting suggestions for improvement. The modifications were made accordingly. Items were arranged according to their expected level of difficulty. The easiest question was included in the beginning for motivating the students. The draft form was printed in the form of booklet. Necessary directions were provided on the front page of the booklet. Separate answer sheets were printed. Sufficient copies of the question papers and answer sheets were printed for try out.
Try out

For standardization item analysis has to be done. For this try out, the Pilot test was first administered to a small group of 100, standard VIII students, selected by stratified random sampling procedure, from two schools in Kottayam District and one school in Pathanamthitta District. The table showing details of the schools and the sample selected for try out is given below.

Table 4.6
Schools and Sample Selected for Try out of Achievement Test

<table>
<thead>
<tr>
<th>Name of School</th>
<th>Boys/Girls</th>
<th>Rural/Urban</th>
<th>Govt/Pvt</th>
<th>No. of Pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. Annes high school, Changanacherry</td>
<td>Girls</td>
<td>Urban</td>
<td>Pvt.</td>
<td>40</td>
</tr>
<tr>
<td>S.B High School, Changanacherry</td>
<td>Boys</td>
<td>Urban</td>
<td>Pvt.</td>
<td>40</td>
</tr>
<tr>
<td>Govt. V.H.S.School, Elanthoor</td>
<td>Girls &amp; Boys</td>
<td>Rural</td>
<td>Govt.</td>
<td>20</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Enough time was given to the students to complete the test. Separate answer sheets were printed for answering the test. Scoring key was prepared. The scoring was done, by giving one mark for each correct response and zero mark for each wrong response. The result was subjected to item analysis.

Item Analysis

The two types of item analysis – Quantitative item and Qualitative item analysis were employed in the present study, to identify items that are deficient in some way, so as to pave the way to improve or eliminate them.

As a part of Quantitative item analysis, the Difficulty index which indicates the proportion of students who answered the items correctly, and the Discrimination Index which is a measure of the extent to which a test item differentiates between students who do well and those who do not do well on the overall test, were determined using Kelley’s method (Kelley, 1939).
1. First test was administered and scores were calculated for each individual student.

2. The papers were arranged from highest to lowest.

3. The papers were separated into an upper group, which consisted of first 27% and a lower group, which consisted of last 27%, based on total test score.

4. For each item, the number of correct response in the upper group were counted and it was indicated as U

5. For each item, the number of correct response in the lower group was counted and it was indicated as L.

Then difficulty index was calculated using the formula $Di = \frac{(U+L)}{2N}$

Discrimination Power was calculated using the formula $Dp= \frac{(U-L)}{N}$

The items for the final test were selected according to the steps supported by Garrett (1973). Items with Di of .3 or more and less than .7 and Dp above .4 are regarded as satisfactory. Care was taken to select the items satisfying these criteria.

**Preparation of final test**

Out of the items included in the try out 24 each were selected for each chapter for the final test. To guide the proper selection of each item, difficulty index and discrimination power were determined, and it was used to determine whether the item should be eliminated. Experts were consulted to check whether distractors were eliminated or modified.

Frisbe, (1971) has suggested that a multiple-choice items having four /five responses can be responded in about 75 seconds. Taking into consideration his suggestions and the time taken by the students in the preliminary try out, the time duration of the final test for each chapter was fixed as 30 minutes. The final test was also printed in booklet form with all necessary instruction. Separate answer sheets were printed for answering test. Sample achievement test is given as appendix.
Evaluation of Achievement Test

Reliability of Achievement Test

Split half method was employed to determine the reliability of the test as it is regarded as the best of the methods for measuring test reliability (Garrett, 1965). The test was split into two halves that are equivalent considering the even and odd items separately. The total score for each student on each half was determined and the correlation between the total scores of both the halves was computed.

Reliability coefficient of the whole test was estimated using the Spearman-Brown Prophecy formula $r_{11} = \frac{2r}{1+r}$ where $r_{11}$ is the reliability of the whole test and $r$ is the reliability coefficient of the half test, (Garrett, 1965). Values of split half reliability coefficient of the posttest of the six chapters are consolidated in the following table, which indicates the test is highly reliable.

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Reliability Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set</td>
<td>.92</td>
</tr>
<tr>
<td>Formation of Geometric Principle</td>
<td>.90</td>
</tr>
<tr>
<td>Algebra</td>
<td>.91</td>
</tr>
<tr>
<td>Mensuration of Plane Figures</td>
<td>.87</td>
</tr>
<tr>
<td>Simple Equation</td>
<td>.90</td>
</tr>
<tr>
<td>Statistics</td>
<td>.91</td>
</tr>
</tbody>
</table>

Validity of the Achievement Test

As far as the present achievement test is concerned, content validity, construct validity and empirical or statistical validity were determined.

Content Validity

Qualitative item analysis was done to ensure content validity. To include items in the test, the Mathematics textbook of Standard VIII was very thoroughly and minutely analyzed. Experts scrutinized the result of the analysis even before the items were finalized so as to ensure coverage of the
content as well as the depth of the study expected. The prepared items were refined, modified and in certain cases omitted in the light of expert criticism. As such the preparation of the present test and procedure adopted for the test construction ensures content validity of the test to be of high degree.

**Construct Validity**

The items from each content were given adequate representation in the test and the items were arranged in logical order. The sentence style varied in variety and also in length. Effective use of words was made by selecting precise meaning. Easily readable and comprehensive sentences were used in all the questions. Before finalizing the items expert opinion was taken into consideration. Thus it can be concluded that the achievement test prepared by the investigator fulfilled the requirement for effective expression. Hence the test has good construct validity, as indicated through the Qualitative item analysis done.

**Empirical or Statistical Validity**

The product moment coefficient of correlation was calculated for the achievement test scores. The achievement test scores have been correlated with Mathematics proficiency Score of students and the coefficient of correlation have been found out. The values are consolidated below.

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Coefficient of correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set</td>
<td>.86</td>
</tr>
<tr>
<td>Formation of Geometric Principle</td>
<td>.84</td>
</tr>
<tr>
<td>Algebra</td>
<td>.88</td>
</tr>
<tr>
<td>Mensuration of Plane Figures</td>
<td>.87</td>
</tr>
<tr>
<td>Simple Equation</td>
<td>.86</td>
</tr>
<tr>
<td>Statistics</td>
<td>.83</td>
</tr>
</tbody>
</table>

The values in the table indicate that the test is reasonably valid one.
Objectivity

The objectivity of a test affects both validity and reliability of the test. Only objective type test items were included in the test. Objectivity was also ensured by using scoring key for valuation.

Practicability

The present achievement test satisfies the following aspects.

1. It is easy to administer.
2. Interpretation is easy and simple.
3. As separate answer sheets are provided, it is reusable.
4. It is economical.
5. Time to administer the test as well as scoring is simple as window stencil method is adopted.

Hence the test has good practicability.

4.4.5 Tests to measure Instructional and Nurturant effects

With the help of the supervising teacher, the investigator developed and standardized tests to measure Instructional and Nurturant effects of Advance Organizer Model. The test was operationed on the basis of the theory of Ausubel, Donald P Kauchack, Paul D Eggen, Hilda Taba and Shirley W. Schiever as mentioned in Chapter II. By consulting with the experts, the investigator decided to develop four tests based on the factors identified for measuring Instructional and Nurturant effects of Advance Organizer Model.

1. Test to Measure Development of Conceptual Structure
2. Test to Measure Development of Meaningful Assimilation of Information and ideas
3. Test to Measure Development of Habit of Precise Thinking
4. Test to Measure Interest in Inquiry

The investigator took special care to include items which involve mental operations having direct relation with the major factors identified for each of the Instructional and Nurturant effects. The items for the first three tests were included from the selected area of standard VIII Mathematics Text
Methodology

Book, in the form of objective type multiple choice questions with 5 alternative responses provided while the fourth test was in the form of an inventory.

4.4.5.1 **Test to Measure Development of Conceptual Structure**

The test items under this head presents situations for listing, grouping labelling subsuming and recycling from the selected 6 topics of standard VIII Mathematics. For the final test, forty multiple choice items were to be included from each of the selected 6 chapters to measure this ability. The respondent has to choose the correct response from the distractors provided. The correct answer was given a score of one and incorrect answer was given zero score.

4.4.5.2. **Test to Measure Development of Meaningful Assimilation of Information and ideas**

This test is to identify students’ strength for linking information, storage capacity, organization and elaboration ability. For the final test the respondent was to provide with 10 different multiple choice items with 5 alternatives based on the 6 chapters of Mathematics text book for each of these 4 component of this Instructional Effect. The respondent has to select the correct response from the distractors. The correct and incorrect response was given a score of 1 and respectively.

4.4.5.3. **Test to Measure Development of Habit of Precise Thinking**

Items for this test were included after adequate, thorough and extensive planning based on the students ability for observing, finding patterns and generalization, forming conclusion based on patterns, assessing conclusion based on observation and thinking critically. Based on each of these five factors 8 different questions were to be framed for the final test from each of the six chapters of the Standard VIII Mathematics Text Book

**Selection of test item**

After a thorough analysis of Mathematics text book of standard VIII, sufficiently large number of items were prepared. These were discussed with experts and got corrected and edited to rectify the apparent defects. Then the accepted items were printed as a pre-test and administered to a sample of
100 students from Kottayam and Pathanamthitta district. The pretest was then scored and the result was subjected to item analysis. Accordingly the difficulty index and Discriminating power of the items were determined as per normal procedure. The details of the result have been summarized in the tabular form prescribed. Items having high degree of discriminating power and difficulty index have been selected. Sufficient number of items as decided earlier was selected to be included in the final test. The instruction for the candidates and scoring key were also developed in tune with normal procedure. A copy of the final tests based on these three effects is given as Appendix.

The content validity of the test has already been taken care of by comparing it with prescribed curriculum material and on the basis of the discussion held with experts.

Items for each of these three tests were arranged in logical order. Care was taken to use effective use of words with precise meaning. Each of the questions were framed using easy, readable, comprehensive sentences, which varied in variety and also in length. This indicates good construct validity of these tests.

Statistical validity was determined by comparing the scores with Mathematical proficiency scores of the students represented by average of their Mathematics achievement scores during the previous year as evidenced by the examination result.

Only objective type test items were included in the test. Use of scoring key in the time of valuation makes the test objective.

These three tests were easy to administer, easy and simple to interpret. Reusable answer sheet were used. Simple scoring procedure was employed. Thus the three tests have good practicability.

4.4.5.4. Test to Measure Interest in Inquiry

The present test to measure Interest in Inquiry, developed by the investigator with the help of the supervising teacher consists of inventory type of scale. Interest in Inquiry developed through the learning to Mathematics,
can be measured by determining the level of interest of an individual in identifying a problematic situation, the relevance of the hypothesis formulated for solving the problem, the method adopted for gathering of data, approaching the data in order to determine the tenability of the hypothesis and thereby arriving at a generalization. Thus six different statements about likes and dislikes are included for each of these five major components. Each item is in the form of statements of which three items are positive statements and three items are negative statements. Thus there are 15 positive statements and 15 negative statements in total. The statements are arranged on a five point scale Strongly like, like, indifferent, dislike and strongly dislike.

The students are instructed to read each of the statements clearly and indicate after each statement listed below whether they would like to perform that activity or not. For responding to each statement the student need not consider the social norms. They need only consider whether or not they would like to do what is involved in the statement. They are informed that they are not asked whether they would take up the work mentioned in the statement, permanently, but merely whether they would enjoy that kind of work, regardless of any necessary skills, abilities or training which you may or may not possess. The students has to put a circle against, Strongly like, like, indifferent, dislike and strongly dislike for each item. Weight 5,4,3,2,1 are assigned to these options respectively for positive statements and weights are reversed for negative items.

**Reliability and Validity**

To establish the reliability of the test, split half method was used. It was found to be .87. To establish the validity of the test the test scores are validated against teachers rating. The teachers were requested to rate the pupils according to their Mathematics interest on a five-point scale. Then using the rating the scores obtained by using interest inventory were correlated and it was found to be .69. The coefficient of correlation of the two was found to be .78. A sample of the inventory is given in the appendix.
Before finalizing the items, they were thoroughly and minutely analyzed by experts. Some of the items prepared were refined, modified and in certain cases omitted in the light of these criticisms.

A copy of the inventory is presented as appendix.

4.5 EXPERIMENTATION AND DATA COLLECTION PROCEDURES

An experimental study was designed to examine the effectiveness of AOM in the teaching of Mathematics. Study was conducted on two groups which are equated for all relevant related variables.

The investigator had intended to conduct a long term study, that too, giving more stress to the Instructional and Nurturant effect of Advance Organizer Model. Review of related study indicates that no studies are conducted related to the evaluation of Instructional and Nurturant effects by identifying factors related to the effects. Joyce and Weil stresses that by imparting study materials through Advance Organizer Model, there will be development in Conceptual Structure at the same time Meaningful Assimilation of Information takes place. Moreover, Interest in Inquiry develops together with Habit of Precise Thinking. Going through various learning theories, it was surprisingly found that Ausubel's view is similar to or in some cases coincides with other learning theories. For the present study investigator adopted such a classification for each of the Instructional and Nurturant effects of Advance Organizer Model after thorough analysis and further consultation with few experts. The investigator had to prepare lesson plans based on Standard VIII text book for the whole academic year and accordingly evaluation tools for instructional as well as nurturant effects, purely in tune with these aspects. It was hence determined that the group selected for comparison for the conduct of experiment should contain more than 30 members, because that would be a handy sample which is at the same time large enough.

The investigator was a high school assistant in Government High School Marayoor, Idukki District. The experiment lasted for whole academic year. Moreover, the investigator was handling students of standard VIII and
was very much aware about the status of the students. Regarding the nature and purpose of the project, it was decided that the experiment could be conducted in the same school. The intention of the project was clearly and deliberately explained to the headmaster. According to the suggestion of the class teacher and teachers handling other subjects, students of standard VIII, reported to be comparable, were seated in two divisions. Even though the teachers certified that the two groups selected were really comparable in all respects, it was empirically verified.

Scholastic achievement scores in three terminal examinations in Mathematics, in the previous year, of the selected students, was taken from the school records and the average of these three scores of each students was determined. This indicated the ‘previous year achievement score’ and this was in turn treated as ‘General Mathematics Proficiency Score’. The investigator applied proper statistical technique and founded that the groups were matched for Means and SD on the basis of these scores. By matching the group based on this core, almost all variables affecting achievement can be said to be controlled to some extent.

Review of related study revealed that intelligence is highly related to achievement. Special care was taken to match the groups based on intelligence. Hence, Kerala Nonverbal Group Test of Intelligence for Secondary School (Nair,1968). was administered in both the groups and individual score of each student was determined and this was subjected to proper statistical treatment. The result of statistical technique revealed that, the groups were matched for Mean and SD on the basis of intelligence.

Developing pre-requisite understanding, is building readiness for learning (Holmes,1985). For mastering a new topic, pre-requisite of that particular content area should be familiar to the learners. The investigator found that the two groups were matched for Mean and SD on the basis of pre-requisite. But all the learners did not know all necessary and sufficient pre-requisites. Hence an immediate and necessary feedback was provided and ensured that both the groups were equated on the basis of pre-requisite also.
While taking the two groups for the experiment the number of boys and girls and were made equal. Regarding the locale there was no question of selection, because all the subjects included in the two groups belong to the same locale, namely, rural. In addition to these all factors, time of day and treatment length in time was equated.

The two groups of students were also equated on the basis of scores obtained for a test to measure the Interest in Inquiry, prepared by the investigator.

Thus, the two groups selected for the study were equated for all relevant related variables. In view of the fact that, matching on the basis of more than one variable is ordinarily not worthwhile unless, the matching variable are themselves relatively independent or uncorrelated with each other (Guilford, 1965). Hence, intelligence which is highly related with achievement, is taken as the matching variable.

Having obtained two equivalent groups, the investigator herself conducted the experiment in both the groups, in order to control the teacher factor. One group was taught using AOM and other by CM. Treatments were randomly assigned to the groups. The group taught using AOM was considered as the Experimental Group and that taught using CM was treated as the Control Group. The investigator herself conducted the experiment in both the groups, in order to control the teacher factor. As mentioned earlier the study was decided to be conducted using ‘Post test only Equivalent Group Design’ (Best,1992). Immediately after the conduct of the instruction the achievement test was administered and the results were subjected to statistical analysis.

Learning and retention of what has been learned may be thought of as a continuous process. It is impossible to measure learning without also measuring retention, for the occurrence of learning can be judged only by the amount retained and used (Pressey, Robinson and Hurrocks,1967). Hence in the present study the investigator intended to measure retention of the learned material.
One of the methods of measuring retention is to test students at the end of a learning experience and then retest them after a period of time (Pressey, Robinson and Hurrocks, 1967). In the present study in order to compare the retention score of two groups the following procedure was adopted. The same test, which was administered after the experiment, was re-administered to the two groups after a gap of two weeks and scores of each individual student is determined. Thus every student got a pair of scores. From this a retention score was arrived at from the pair of scores using the formula

\[
\text{Retention score} = \frac{\text{scores obtained in the second test}}{\text{scores obtained in the first test}} \times 100
\]

Thus, determining the retention score of student in both groups, the Mean and SD of retention score for the two groups were calculated and subjected to a test of significance of mean difference.

The statistical technique adopted for analyzing the data is explained in brief in the next section.

**4.6 STATISTICAL TECHNIQUES EMPLOYED.**

Detailed description of statistical technique employed to test the tenability of the hypotheses formulated, for the present study, is described in this section.

The investigator selected two groups equated for major controlling variables, for actual experimentation. The null hypothesis formulated for this purpose,

There will be no significant difference, between the Mean scores of,

1. Intelligence
2. General Mathematics proficiency
3. Pre-requisite that is necessary for mastering the new topic
4. Interest in Inquiry, in the two groups
For testing the tenability of this hypothesis “a test of significance of difference between uncorrelated means” using a two tailed test was employed.

Immediately after the experiment, achievement test, tests related to development of Conceptual Structure, Meaningful Assimilation of Information, Habit of Precise Thinking and Interest in Inquiry was administered to two groups which were matched for mean on the basis of intelligence. The scores thus obtained were subjected to a “test of significance of the difference between the correlated mean of groups matched for mean and SD,” using a two tailed test.

The concept of the measured intelligence is based upon the assumption that intelligence is normally distributed throughout limited segments of the population. Interpreted in terms of standard deviation, 68.26% of pupils lying between the mean and one standard deviation above and below mean can be treated as average group. (Best, 1992). Pupil belonging to the lower and higher extremes can be treated as below average group and above average group respectively. Hence, the students in control and experimental group were divided into three groups – low, average and high intelligent group - of students. The scores obtained for tests and their factors related to Mathematics achievement, Development of Conceptual Structures, Meaningful Assimilation of Information, Habit of Precise Thinking and Interest in Inquiry were subjected to a “test of significance of the difference between the correlated mean of groups matched for mean and SD,” using a two tailed test for low, average and high intelligent group of pupils across groups and within groups.

Same tests were re-administered in the two groups, two weeks after the first test. From the scores obtained for these two tests conducted after experiment, a retention score was arrived at. Retention scores were also calculated for the factors related to achievement test as well as for the test based on Instructional and Nurturant effects of the model. These scores were
also subjected to “a test of significance of the difference between correlated means of groups matched for mean and SD,” using a two tailed test.

The retention scores obtained for tests and their factors related to Mathematics achievement, development of Conceptual Structures, Meaningful Assimilation of Information and Habit of Precise Thinking were subjected to a “test of significance of the difference between the correlated mean of groups matched for mean and SD,” using a two tailed test for low, average and high intelligent group of pupils across groups and within groups.

The level of significance should be set up by the investigator before collection of the data (Garrett, 1981). The .01 level of significance is more exact than the .05 level (Garrett, 1981). Hence, the investigator set .01 as the level of significance for acceptance or rejection of null hypothesis. Size of sample selected of the experiment was more than 30. ‘Large sample ‘t’ Critical Value’, of the two tailed test of the rejection of null hypothesis at .01 level is 2.58 (Best, 1992). If the CR is 2.58 or larger then the null hypotheses can be rejected at .01 level of significance (Garrett, 1981).

The details of the analysis is given in chapter V.