CHAPTER: 4.0
CONSTRUCTION OF INSTRUCTIONAL DESIGN AND MEASURING TOOL

4.1 Introduction

In the given study Concept Attainment Model of Instruction was constructed. Investigator had to find the effectiveness of the Concept Attainment Model of Instruction on learners with different achievement levels. For this investigator also prepared Standardized Unit Achievement Test in Mathematics for various concepts of the topic “Sets”. Details about the development of Concept Attainment Model of Instruction and Standardized Unit Achievement Test in Mathematics are presented in the present chapter.

For preparing lesson transcripts using Concept Attainment Model of Instruction, outline given by Weil and Joyce (1978) was used. In order to develop Standardized Unit Achievement Test in Mathematics the steps suggested by Joshi (1991) were followed. This Chapter is thus divided into two parts. The first part is about preparation of lesson transcripts based on Concept Attainment Model of Instruction. The second part explains development and standardization of Unit Achievement Test.

4.2 Development of Concept Attainment Model of Instruction

There are three instructional strategies of Concept Attainment Model of Instruction – Reception oriented, Selection oriented and Un-organized material as discussed earlier in chapter – 2. From these strategies Reception oriented Concept Attainment Model of Instruction was used. Various steps were followed which are discussed as below;

1. **Subject and Selection of Unit.** Under this step for teaching, subject and unit were decided. In this study the unit 'Sets' in the subject “Mathematics” of Std. 9 was selected and medium of teaching was English.

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2. **Content Analysis.** The analysis of the topic 'Sets' of subject Mathematics for class 9 was done as follows:

   Concepts from the topic “Sets” were as follows:

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<tbody>
<tr>
<td>1. Set definition</td>
<td>9. Disjoint sets</td>
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<td>2. Elements of a set</td>
<td>10. Subset</td>
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<tr>
<td>5. Infinite set</td>
<td>13. Complement of a set</td>
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<td>7. Singleton set</td>
<td>15. Intersection of sets</td>
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<td>8. Equal sets</td>
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</table>

3. **Determination of Objectives.** After deciding the subject and unit it becomes essential to decide the objectives. Aims are clear and interpretation is done in easier language. Aims are written in form of expected behavior. The curriculum and textbook of Mathematics of Std. 9 were referred. The determined instructional objectives are mentioned in Appendix-A.

4.2.1 **Construction of Lesson Plans based on Concept Attainment Model of Instruction**

   After deciding the subject and content with the objectives at centre the next task was done to prepare lesson plans based on Concept Attainment Model of Instruction.

   Instructional Models of Concept Attainment are based on studies of Bruner (1967) describing the process by which learners discriminates essential features of things and group them together.

   In the model outlined by Weil and Joyce (1978), new concepts are taught by presenting sequence of examples and non examples. In this process teacher presents examples initially and later ask students to respond and find essential attributes so that they can give examples on their own. The phases in this model are already discussed in chapter-2.

   Tennyson and Park (1980) reviewed research in the area of “Reformation of Concept Attainment Model” and pointed out inclusion of reception strategy in it. In this strategy if the students are having any confusion while acquiring abstract concept, the instructor can immediately adapt new presentation of information accordingly.

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5Tennyson and Park *The teaching of concepts* – A review of instructional design research literature in education. 1980, pp. 55 to 70.
They also emphasized on importance of surrounding structure of concept-like concepts that are easy to understand, already known concepts, very much related concepts to the actual concept to be taught. They also stressed on hierarchical structure of concept as discussed in concept analysis. They have shown mainly four steps. In the first stage instructor analyzes the concept and determines attributes. In the second stage the instructor provides examples and non-examples, in third stage students find attributes and actually judges examples and non examples, in the last stage new set of examples are provided to learners. This model was found effective to increase the understanding and knowledge level of students. Thus in accordance with theories of Bruner (1967), model by Weil and Joyce (1978) and Tennyson and Park (1980) the investigator has prepared Concept Attainment Model of Instruction for the unit “Sets” in Mathematics. The procedure followed for concept analysis is described in detail as follows:

1. **Concept Name.** The concept name is the label attached to the mental construct, and that name is used for further communication.

2. **Concept Definition.** A concept definition is a statement that summaries the description of the concept and helps a learner achieve a form of closure related to it.

3. **Characteristics.** The common features that describe a concept are called the concept’s characteristics or attributes. The ease or difficulty of learning a concept is dependent upon the number of characteristics a concept.

4. **Examples and Non-examples.** Concept is learned through generalizing from the common features in an observed class. The learner is exposed to examples and non-examples of the concept, identifies the features common to the examples that are not found in the non-examples and generalizes from these features.

5. **Super ordinate Concept.** Each concept is formed in relation to the other concepts. Super ordinate concept is a larger set in to which the concept fits. For example super ordinate concept of trapezoid is quadrilateral.

6. **Sub ordinate concept.** Sub ordinate concept is a smaller set, which fits in the concept. For example the sub ordinate concept of parallelogram is rhombus or square. Sub ordinate concepts help to form examples.
7. **Coordinate Concept.** The concept, which has a coordinate relationship with the referred concept within a frame of reference, is called a Coordinate concept. Coordinate concept helps to frame non-examples.

8. **Preparation of content goal.** The Concept Attainment Model focuses on concept learning. The content goals for a Concept Attainment Model lesson can be planned according to the developmental level of children and demand of the particular situation. The thinking processes are more demanding in the concept attainment activity because students are asked to hypothesis a label for the concept. The implementation phases of Concept Attainment Model is very flexible and fun for both the instructor and the students because the process can be presented as a type of game which, combined with its inherent sense of the unknown, results in increased student motivation.

### 4.2.2 Phases of Concept Attainment Model of Instruction

According to methodology point of view following are the phases of Concept attainment model. This is an instructional model hence it gives outline to teacher regarding classroom work.

**Phase 1: Establishment of a Relaxed Atmosphere.** Pupil must feel free to express ideas without fear of ridicule or failure. Therefore teachers should do their best to convince the students that are free to play with ideas. Regardless of how silly some contribution may seem, teacher should avoid ridiculing those who makes them. If one or more students laugh when a classmate says something, the teacher should do her best to gloss over the incident by noting that the idea is worth.

**Phase 2: Analysis of Conceptual Network Involved.** Concepts exits in context as part of larger network of concepts. There are super ordinate concepts and coordinate concepts. Effective learning of a concept can be made easy, when the knowledge of the concept can be tied with its super ordinate and sub ordinate concepts. The teacher should ask the students to discuss their experiences and familiar concepts relating to the concept under consideration. Here a process of tying down the familiar concepts relating to the concept to be taught is being done.

When teacher makes students understand that concepts exist in network, they will establish or extend such networking as they learn new concepts. In this phase the related concepts of the concept, which is going to deal with, be discussed and pupil’s knowledge relating to it can be tested.
Phase 3: Providing Examples and Non-Examples. Teacher will present students a list of examples and non-examples of the concept under consideration. Typically it starts with an example and a non-example presented together and identified as such. The words “yes” or “no” “plus” and “minus” symbols etc have been used for indicating the example is positive or negative.

Phase 4: Response-Sensitive Discussion. In this phase teacher will ask the students to hypothesize possible categories that would encompass the examples. This phase is called response-sensitive because the discussion will change depending on the student’s response. The teacher makes the students to compare attributes describes in positive and negative example. Students generate and test the hypothesis. At the end of discussion the students may be able to state a definition according to the essential attributes. During the analysis of hypothesis the teacher refrain from passing judgments. By doing so, the teacher makes the concepts attainment activity a guessing game.

Thus the teacher should place the responsibility for identifying and verifying the concept at the student. Through the process of analysis and making inferences, students become more proficient in these thinking skills and also more autonomous learners.

Phase 5: Providing more example and non-examples. In this phase teacher will present additional positive and negative examples and students analyze and verify hypothesis and eliminate those not supported by the data.

Phase 6: Students generate Examples. In the light of above process the students generate examples for the prescribed concept.

Phase 7: Defining the concept. By analyzing the hypothesis in the light of examples and non-examples, students will state definition according to the essential attributes. Teacher will confirm the hypothesis, name the concept and restate the definition according to the essential attributes.

Phase 8: Assessing the Attainment of Concept. In this phase, the teacher evaluates the level of concept attainment of the students. It is tested by presenting unlabelled examples. Student’s label them as positive or negative examples based on the essential attributes discussed in the 7th phase.

Phase 9: Analysis of thinking strategy involved. In this phase, students begin to analyze the strategies by which they attain concepts. Some students initially try broad and gradually narrow the field and some begin with more discrete constructs. The
learners can describe their pattern of thinking. Finally they can compare the effectiveness of several strategies.

The age, cognitive structure and previous knowledge of the students were also taken into consideration while preparing these lesson plans. Sample classes were taken and school teachers observed the teaching-learning activities and sufficient modifications have been done taking in to account the suggestions put forward by them. The sample lesson plan is shown in Appendix A and all other lesson plans are provided in CD-ROM.

4.2.3 Piloting of Concept Attainment Model of Instruction

Any presentation before having its educational use it is must to do its primitive testing. On basis of it certain changes can be done. For it opinion of teachers and students were taken and some of the experts were asked the same.

- **Opinion of Experts.** For presentation the opinion of the experts is taken. Lesson plan format, examples, non examples, attributes, definition of concepts, instructional design, teacher-students discussion, charts and other approaches were considered. On basis of it appropriate changes were done.

- **Opinion of Teachers.** Content analysis, order of arrangement, content materials related opinions were obtained. The exactness of the content can be checked.

- **Piloting and Opinion.** Testing was done on the students of small group. Examples, non examples, attributes, definition of concepts, size of charts, fonts in the chart, color combinations etc. were checked.

Thus finally Concept Attainment Model of Instruction was developed keeping in touch with students, teachers and subject experts.

4.2.4 Final Form of Concept Attainment Model of Instruction

According to the various opinions the changes in the presentation were done. Some of the experts suggested doing some changes in examples and non-examples. Some suggested changes in listing attributes. After editing the final form was prepared.

4.3 Standardized Achievement Test

Appropriate evaluation is very much essential to find whether the educational objectives are achieved after providing planned learning experiences. Educational
process is incomplete without proper measurement. According to Ross (1959)⁶ - Measurement directly demonstrates the quality of pupils learning and it also reflects the quality of teachers’ teaching.

It is obvious that standardized achievement test provides more authentic results than teacher made test so the investigator had prepared standardized achievement test in Mathematics also no readymade tests were available so investigator decided to prepare achievement test and then standardized it.

4.3.1 Meaning of Standardized Achievement Test

Various scholars have given different meanings of standardized achievement test. Joshi (1991)⁷ says that “The test which measures the behavioral changes of sample without subjectivity and with appropriate standards is called standardized test”.

According to Desai and Desai (1992)⁸ depending upon the usage of standardized test says that “In order to find how much knowledge an individual have achieved or how much understanding is attained what are the skills achieved, the test is given. This type of test is called standardized achievement test.” Poojara and Bhavsar (1970)⁹ says that “The test developed to find in a group for particular subject what are the objectives like knowledge, understanding or skills achieved is called achievement test.”

Hence it can be concluded that standardized achievement test is a tool developed to measure behavioral changes of the group without subjectivity and following certain standards of measurement. Here investigator has decided to measure knowledge, understanding, application and analysis. Objective test will be prepared so that no subjectivity comes in between. Due care will be taken that measuring tool prepared would be reliable, valid, practicable and scoring key with user manual would also be provided.

4.3.2 Steps to be followed for Test Construction

Experts have suggested different steps for test construction. Opinions of various experts regarding steps to be followed while preparing standardized achievement test are as follows:

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According to Desai (1972)\textsuperscript{10} the steps for construction of achievement test are:

- To decide what are the objectives? As once we decide the teaching goals regarding the content we can prepare questions accordingly. Teacher is required to prepare draft form and analyze the questions. It becomes then essential to do the testing of those questions on group of pupils. Final form of the test should be created. Validity and reliability of test should be found. Selection of sample is done and investigator is required to find norms and evaluate further. Pictorial presentation of the steps is as;

```
Decide objectives
↓↓↓
Prepare draft form
↓↓↓
To do piloting and analyze questions
↓↓↓
Prepare final form
↓↓↓
Check validity and reliability
↓↓↓
Select sample
↓↓↓
Give test
↓↓↓
Find norms
↓↓↓
Do evaluation
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Figure 4.1

**Steps to be followed for Test standardization**

Lindquist (1980)\textsuperscript{11} has given following five steps:

1. Preplanning of items
2. Prepare items
3. Piloting and analysis of items
4. Construction of test and its implementation

5. Analysis of scores: reliability, validity and norms to be established

Brown Fredrick (1983)\(^\text{12}\) gave six steps for standardizing test;

1. Pre study for test
2. Construct draft form
3. Piloting and item analysis
4. Construct final form
5. Implementing test
6. Other technicalities to be completed related to test

According to Joshi (1991)\(^\text{13}\) following are the six steps to be followed for construction of standardized achievement test:

1. To do pre study for constructing test
2. Construct test items
3. Do piloting of test
4. Construct test
5. Implementation of test on sample
6. Analyze scores to evaluate test

Here the investigator has used these six steps for constructing and standardizing achievement test in mathematics for the topic “sets” in class 9 according to the syllabus prescribed by Maharashtra State Education Board.

### 4.3.3 Steps followed while Constructing and Standardizing Unit Achievement Test

Achievement test can be defined as a test designed to measure the effect of specific teaching or training in an area of curriculum. The investigator has followed six steps as mentioned above its detailed explanation is done as;

#### 4.3.3.1 Pre Study for Test

Appropriate understanding about test construction is very much essential hence investigator studied textbook, references related to content, teacher’s handbook, various researches related to test construction, achievement tests in various subjects. Extensive planning for constructing test is required. Two things are to be kept in mind: firstly what is to be tested? And second is how to test? The first issue deals with the purpose of test, its objective and content of test while second deals with procedure


of testing. Let us discuss firstly first issue. Various aspects are studied and discussed in detail as below:

1. **Purpose of Test:** Achievement test was constructed to judge pupils’ accomplishment in concepts contained in the topic “Sets”. The test also purposes to grade pupils in terms of their achievement.

2. **Specification of Course Content:** The next important step is to specify the content from which test is to be prepared. The chapter selected was “Sets” from class IX of Maharashtra State Board. Various concepts included in the chapter are listed as;

   - Sets
   - Elements of a Set
   - Cardinality of a Set
   - Finite Set
   - Infinite Set
   - Null Set
   - Singleton set
   - Equal Sets
   - Disjoint Sets
   - Subset
   - Power Set
   - Universal Set
   - Complement of a Set
   - Union of Sets
   - Intersection of Sets

   Proper study was done on each of the above concepts included in the topic “Sets”. Opinions of various experts were taken to give appropriate weightage to all concepts. Investigator has taken help from ten Mathematics teachers teaching in class IX in Mumbai city following Maharashtra Board syllabus. Weightage suggested by them is shown in the tabular form as;

   **Table 4.1**
   **Score for each Concept according to Experts opinion**

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<th>Concepts</th>
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</table>

3. **Deciding Instructional Objectives:** From the three domains- Affective, Cognitive and Psychomotor investigator is dealing with the Cognitive domain. So
the investigator selected objectives from cognitive domain pertaining to subject Mathematics on the topic “Sets”. They were: (1) knowledge, (2) Comprehension, (3) application and (4) analysis.

The weightage given to above objectives as per the opinion of experts is shown in the tabular form as;

Table 4.2
Experts’ opinion about allotting Marks to Objectives

<table>
<thead>
<tr>
<th>Experts</th>
<th>Knowledge</th>
<th>Understanding</th>
<th>Application</th>
<th>Analysis</th>
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From the above table average weightage to be given to each objective was calculated it is shown in the table 4.3

Table 4.3
Total Percentage allotted to each Objective

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<tr>
<th>Sr. No.</th>
<th>Objectives</th>
<th>Marks</th>
<th>Percentage</th>
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</tbody>
</table>

Thus four objectives were selected and appropriate weightage was given to them.

4. Selection of Item Format and Deciding Form of Test: It is essential that an item should measure what it intends to measure. Thus it was obvious to prepare objective type of test to have zero subjectivity and have no bias. The investigator constructed objective type of test with four alternatives which include one correct answer and rest are distracters.
In introducing test necessary information was provided to students, administrators and supervisors. Adequate information about time limit, format of answering etc. was provided.

5. Blue Print of Test: Blue print is a three dimensional chart containing coverage of content, objectives and type of questions. The cell in the blue print represents the number of items to be included in the test in relation to any particular objective. According to Mehran and Lehman (1973)\textsuperscript{14} there is no hard and fast rule that can be prescribed for teacher to use in determining the weightage to be assigned to various cells in blue print, experience is the best source. Hence taking help of tables 4.1 and 4.2 investigator prepared blueprint as shown in table 4.4;

<table>
<thead>
<tr>
<th>Concept No.</th>
<th>Knowledge</th>
<th>Understanding</th>
<th>Application</th>
<th>Analysis</th>
<th>Total</th>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>14</td>
<td>12</td>
<td>11</td>
<td>50</td>
</tr>
</tbody>
</table>

Thus above table indicates the weightage given to various objectives according to the content. Test items were constructed according to the above table 4.4.

4.3.3.2 Construction of Test Item

Investigator took help from various books and test papers of various schools. The investigator also consulted various teachers and keeping in mind their opinions tried to prepare test items. It is obvious that whatever number of items is expected in


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the final test double number of items should be prepared. The investigator wanted to develop test containing 50 items so the draft plan was prepared with 100 items. Majority of items were intended for average students but dull and intelligent students were also considered while constructing test. Finally after the items were prepared the test was shown to various experts and necessary modifications were done as per their opinions.

4.3.3.3 Piloting of Test

For Standardizing a test its item analysis is very much essential. For this the test should be given to small group representing population and this process is called piloting. Objectives for doing piloting are:

1. To decide the difficulty value of test items.
2. To obtain discriminating index of test items.
3. To check effectiveness of distracters.
4. To find whether adequate information is provided to supervisors.
5. To find the effectiveness of test format.
6. To find the actual time limit for completing test.

In order to fulfill first three objectives it is essential to do item analysis. Rests of the objectives are self satisfied once the test is administered on small group. The test was given to small sample of 200 students from the randomly chosen schools of population to find answers to questions like- How much is each item difficult? To what extent an item differentiates high scorers and low scorers? Is there any complexity in language or format of item? How effective are distracters? Details of sample chosen are given in the table as;

Table 4.5
Sample chosen for Piloting of Achievement Test

<table>
<thead>
<tr>
<th>Schools selected</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anjuman High School, Andheri-W</td>
<td>60</td>
</tr>
<tr>
<td>Oxford High School, Kandivali –E</td>
<td>54</td>
</tr>
<tr>
<td>Pancholia High School, Kandivali-W</td>
<td>58</td>
</tr>
<tr>
<td>St. Lawrence High School, Borivali-E</td>
<td>48</td>
</tr>
<tr>
<td>Total</td>
<td>200</td>
</tr>
</tbody>
</table>
Enough time was provided to students to complete their test. Answer sheet was given separately with the test booklet. The scoring was done as giving one point credit for each correct response and zero point for wrong answer. The test consisted of 100 questions of one mark each so total of 100 marks. The draft plan is provided in Appendix B. Details about item analysis is described as below:

4.3.3.1 Item Analysis

Item analysis is the process of establishing suitability of an item for inclusion in final test. The quality of each item is found by analyzing three important characteristics of each item. They are Difficulty Value, Discriminating Power and Distracter Analysis.

Kelley’s method (Kelley1939)\(^{15}\) was used to calculate difficulty index and discriminating power. Based on the scores obtained papers were arranged in descending order of magnitude ie. from highest to lowest. Then papers of first 27% (54 students) and last 27% (54 students) were used for item analysis.

1. Difficulty Value of each item: For any item how many students were successful in answering each item correctly is called its difficulty value. Difficulty value is the number that indicates how many students answered the item correctly. In short it indicates the quantity of students who answered the item correctly.

The formula used for calculating difficulty valve is

\[
D.V. = \frac{R_U + R_L}{2N}
\]

Where D.V. = Difficulty Value of each item

\[R_U = \text{The number of pupils in the upper group who answered correctly}\]

\[R_L = \text{The number of pupils in the lower group who answered correctly}\]

\[N = \text{Total number of pupils in each group}\]

2. Discriminating Index for each item: How much does an item discriminates between bright and a dull pupil is called its discriminating index. It means that if discriminating index of any item is high then it clearly indicates the difference between bright and dull students. The formula used for finding discriminating index is

\[
D.I. = \frac{R_U - R_L}{N}
\]

Where D.I. = Discriminating index of each item

\[ R_U = \text{Number of pupils in the upper group who answered correctly} \]
\[ R_L = \text{Number of pupils in the lower group who answered correctly} \]
\[ N = \text{Total number of pupils in each group} \]

3. **Distracter Analysis:** In addition to difficulty value and discriminating index, the effectiveness of distracters was also checked. Distracters are those responses provided with the actual answer that attracts dull students to mark it as their correct response. These alternatives attract those students more who are unaware of correct answer. Hence it is essential that distracters should be very attractive as only those students who know the correct answer can only choose the correct response. From the total answer sheet the distracters having less than 4% response were discarded. It was considered that students from lower group have chosen those responses more than students form upper group. All the distracters were thus selected properly with appropriate care.

4.3.3.3.2 **Implementations from piloting**

The implementations obtained from piloting are as follows:

- It is must to provide all instructions in written form as oral instructions are ineffective in big classes with more students.
- Ample time should be provided to read instructions. Investigator provided five minutes time.
- Firstly emphasis is to be given on filling up primary information.
- See that pupils are writing only in answer sheet and not in test booklet. Provide extra sheet for rough work if necessary.
- Frisbee (1971)\(^{16}\) suggested that multiple choice items with four to five alternatives can be answered in seventy five seconds.

Hence investigator decided to give one hour twenty five minutes to pupils for answering. This time was sufficient for about 95% of the students in class to complete the test.

4.3.3.4 **Final Test Construction**

After doing piloting of test and item analysis based on them final form of test is constructed. According to blue print with content and objectives each item was chosen. Appropriateness of distracters was checked. Items with appropriate difficulty value and discriminating index were chosen.

\(^{16}\text{Frisbe, Comparative reliabilities and validities of true-false and multiple choice tests, unpublished doctoral dissertation, East Lansing, Michigan: Michigan State University.1971.}\)
According to Natrajan (1977)\textsuperscript{17} items with difficulty value 0.20 to 0.75 should be accepted. Items with difficulty value 0 to 0.25 are considered as hard and should be modified while items with difficulty value 0.75 to 1.00 are very easy items and should be discarded or to be used with necessary modifications. He suggested that items with discriminating index 0.20 to 0.65 are to be used while those items with discriminating index more than 0.60 are very proper for usage but those items with discriminating index less than 0.20 should be discarded and if needed to be used they should be modified. These details are shown in tabular form as;

\textbf{Table 4.6}

\textbf{Appropriateness of Difficulty Value and Discriminating Index}

<table>
<thead>
<tr>
<th>Difficulty Value</th>
<th>Discriminating Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(First characteristics for choosing item)</td>
</tr>
<tr>
<td></td>
<td>0 to 0.25</td>
</tr>
<tr>
<td>More than 0.60</td>
<td>Hard</td>
</tr>
<tr>
<td>0.20 to 0.60</td>
<td>Difficult</td>
</tr>
<tr>
<td>Less than 0.20</td>
<td>Modify</td>
</tr>
</tbody>
</table>

Hence investigator has chosen items with difficulty value 0.25 to 0.75 and discriminating index more than 0.20. Taking in to consideration blue print also investigator selected 50 items for the final test. The difficulty value and discriminating index of items selected are given in appendix - D.

\textbf{4.3.3.5 Implementation of the Test on the Sample}

After completing the above mentioned steps finally the test was constructed to be implemented on the sample. Investigator has decided to standardized unit achievement test in mathematics prepared on topic “Sets” on the students of English medium schools in Mumbai city of class 9. So the population was students studying in class 9 in English medium schools of Mumbai city. Mumbai is divided in various

\textsuperscript{17} V. Natrajan, \textit{Monograph on test and Item Analysis for Universities}, New Delhi: AIU. 1977, p. 217.
regions like central suburbs, western suburbs and southern suburbs. Even Navi Mumbai, Thane, Raigarh, Kalyan etc. are included in it. The investigator has chosen western suburbs out of all this regions purposefully keeping in mind requirements of the research topic. Western suburb contains maximum amount of English medium schools of all religions following Maharashtra state Board Syllabus. Hence it was decided to select schools from western suburbs of Mumbai City as a representative of Mumbai City. Details of sample chosen are;

Table 4.7
Sample chosen for Achievement Test

<table>
<thead>
<tr>
<th>Name of the School</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trinity School, Kandivali-W</td>
<td>35</td>
</tr>
<tr>
<td>Smt. Jayaben Khot High School, Borivali-E</td>
<td>43</td>
</tr>
<tr>
<td>HMW English High School, Jogeshwari-W</td>
<td>74</td>
</tr>
<tr>
<td>St. Mary’s English High School, Malad-W</td>
<td>56</td>
</tr>
<tr>
<td>Poorna Pragya High School,Dahisar-E</td>
<td>180</td>
</tr>
<tr>
<td>G.H.High School, Borivali-E</td>
<td>120</td>
</tr>
<tr>
<td>Anjuman Islam High School, Andheri-W</td>
<td>60</td>
</tr>
<tr>
<td>St. Joseph High School, Kandivali-W</td>
<td>47</td>
</tr>
<tr>
<td>Orlem High School, Malad-W</td>
<td>140</td>
</tr>
<tr>
<td>Pal Rajendra High School, Kandivali-E</td>
<td>30</td>
</tr>
<tr>
<td>Oxford High School, Kandivali-W</td>
<td>54</td>
</tr>
<tr>
<td>St. Lawerence High School, Borivali-W</td>
<td>106</td>
</tr>
<tr>
<td>Pragya Bodhini High School, Goregaon-E</td>
<td>160</td>
</tr>
<tr>
<td>Don Bosco High School, Borivali-W</td>
<td>85</td>
</tr>
<tr>
<td>Teresa High School, Andheri-E</td>
<td>42</td>
</tr>
<tr>
<td>Islam High School, Bandra-W</td>
<td>68</td>
</tr>
<tr>
<td>Total</td>
<td>1300</td>
</tr>
</tbody>
</table>
4.3.3.6 Analyzing Scores

In order to analyze scores reliability, validity, practicability and objectivity are found. Its details are mentioned as below:

1. Reliability of the Unit Achievement Test: Reliability is must for any test as it indicates consistency of results. If uniqueness is maintained in test results when measures are taken more than once then test is said to be reliable. Reliability provides consistency that makes validity possible and indicates the degree to which generalizations are justifiable. There are four methods to determine reliability, they are: - (1) Test-Retest Method, (2) Split Half Method, (3) Parallel Forms Method and (4) Logical Congruence Method. Investigator has used all these methods to determine reliability except method of parallel forms. While preparing parallel forms due care must be taken that the other form created is a copy of the original test in terms of objectives and weightage to content. Investigator has to prepare achievement test on only one topic so it was not possible to create another same form of test containing items with same difficulty value and discriminating index.

# Test Re-test Method – In this method test is given to one group and again same test is given to same group after certain time period. Here it is checked whether there is difference between the scores obtained by the pupils in test and re-test. If no difference is found between the scores on both the test then the test is said to be completely reliable.

Achievement test is psychological in nature so various factors like history, maturation, mental health of pupils, test administration, time gap between two tests do play some role. Still if proper time duration is kept between two tests than it is good method to calculate reliability. In this method correlation is obtained between the scores obtained by pupil on both tests. High is the value of correlation more is reliability.

In the present study during final examination of test investigator has given test to 47 students of St. Joseph High School after fifteen days of the test administration the investigator has again taken test of those students. Product-moment method was used to calculate reliability. The correlation between two tests was found to be 0.950. This is the value of reliability through test-retest method. Thus the value being very near to 1 the test is reliable.

# Split half Method – The test is divided into two parts for using this method.
The test is divided into two parts based on odd and even items. Correlation between the scores of two tests is found. This value of correlation is for the half test.

Using Spearman Brown Prophecy Formula \[ R = \frac{2r}{1 + r} \]

Where \( R \) is the reliability coefficient for the whole test and \( r \) is the coefficient of correlation between two half tests containing odd and even items respectively. In the present study investigator selected randomly 80 students and found correlation between the scores of odd and even items. The value of correlation between half tests was obtained as 0.889 and the reliability coefficient was calculated using the above formula was 0.941. Thus the test is reliable.

# Logical Congruence Method – Kruder-Richardson has provided many formulas to find test reliability. Investigator used formula 20:21 to find test reliability. Both the formulae are shown and by proper required calculations reliability is found.

**Kruder-Richardson formula -20**

\[
V = \left( \frac{n}{n-1} \right) \left( 1 - \frac{M_t(n - M_i)}{n \times S_t^2} \right)
\]

Where \( V \) = Reliability Coefficient of test

\( n \) = No. of test items

\( M_t \) = Mean of scores obtained by pupils

\( S_t \) = Standard deviation of scores obtained by pupils

**Kruder-Richardson formula -21**

\[
V = \left( \frac{n}{n-1} \right) \left( \frac{\sigma_t^2 - \Sigma pq}{\sigma_i^2} \right)
\]

Where \( V \) = Reliability Coefficient of test

\( n \) = No. of test items

\( \sigma_t \) = variance of total scores obtained on test

\( p \) = no. of students who answered each item correctly

\( q \) = no. of students who answered each item wrongly

The values obtained by both the formulas are respectively 0.929 and 0.891. These values are very near to 1 that indicates good test reliability.

2. **Validity of the Unit Achievement Test**: Validity of the test actually deals with that to what extent do a test measures what it purposes to measure and does not
measure other characteristics besides mentioned in its purposes. It is said that if there is uniqueness in the scores obtained by pupils on the test with some another test measuring same thing then the test is said to be valid. Validity is always concerned with specific use of assessment results and interpretations of it. As far as an achievement test is concerned content validity, concept or construct validity and empirical or statistical validity are important.

# Content Validity: According to Lindquist (1951)\(^\text{18}\) “The content of an achievement test is often formulated by analysis of curriculum and text pooled by judgment of recognized authorities in the field. Such tests are self defined.” Here the investigator prepared the objective type test keeping in mind two-dimensional blue print that explains the weightage given to objectives and concepts according to experts’ opinion. Thus the achievement test prepared is valid. Moreover the test items are checked on basis of their difficulty value and discriminating index.

# Concept or Construct validity: Investigator selected the topic “Sets” and all concepts in the topic are selected to prepare achievement test. Concepts were organized in a logical sequence and adequate representation was made in the test. Appropriate use of words was done. Style of sentences in the test varied in length and presentation. Questions were easily readable and presented in simple language. The test was effective in expression. Thus the test had good concept validity.

# Empirical or Statistical Validity: Empirical validity is of two types - Concurrent validity and Predictive validity. If correlation is obtained between the scores obtained by pupils on the achievement test prepared by the investigator with some another test with same purpose of then it is called concurrent validity. While if comparison is made between test scores with their future performance or scores of some other tests then it is called predictive validity.

Here the investigator has obtained concurrent validity. In the present study investigator has prepared achievement test on the topic “Sets” for class 9 in the subject Mathematics. Another such test was not available so investigator used marks of the pupils obtained in final exam of Mathematics subject. The investigator selected students of Pancholia High School. Product-Moment Coefficient of correlation was calculated using the scores of achievement test and marks obtained by the pupils in

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Mathematics in their final exams. The correlation coefficient was obtained as 0.823. Thus the test had good empirical validity.

3. Objectivity of the Unit Achievement Test: In the present study investigator has prepared objective type of achievement test. Thus there is no question of subjectivity, biasness or any prejudice. Moreover for evaluation investigator prepared scoring key.

4. Practicability of the Unit Achievement Test: Test is practicable means that it can be easily used. In this test there is ease of administration, proper instructions are provided for pupils for ease in answering, proper time limit, simple language, economic in cost, test booklet can be reused, scoring key is provided for ease of assessment, analyzing result is easy as scores for each item are either 0 or 1. Thus the achievement test prepared by investigator is practicable. The next chapter consists of details about Analysis and Interpretation of Data.