CHAPTER V

INSTRUMENTATION AND CONDUCT OF THE EXPERIMENT:

5.0.0 PROLOGUE:

The present investigation is related to the effect of expository-guided discovery methods of teaching mathematics on the achievements of the students. In earlier researches, it was found that none of the teaching methods was consistently effective than other across all types of pupils. Therefore, methods of teaching interact with pupil characteristics. The researcher was particularly interested in studying the method x intelligence interaction; therefore, the 2 x 3 factorial design was chosen for the study. Similarly, previous achievement affects subsequent achievement; therefore, in the present study, this factor was controlled statistically by using the ANOCOVA technique. For studying the effectiveness of these two methods, the scores obtained by the students on items based on knowledge, comprehension, and application objective were taken as dependent variables. The sum total of knowledge, comprehension, and application scores was taken as total achievement of the students, which was taken as one more dependent variable.

The details about the instrumentation and conduct of the experiment based on the abovementioned points are discussed in this chapter. This chapter deals with the preparation of soft-ware (preparation of lesson notes, pre-achievement test, and post achievement test) and preparation of the hardware for smooth running of the experiment. Lesson planning in
educational experiment on teaching is the most important element in the conduct of the experiment. The next section deals with this important element of the experiment.

5.1.0 PLANNING FOR TEACHING:

According to Noll and Scannel (1972, p.166), teaching involves five essential processes - defining goals or objectives, choosing content, deciding on methods of instruction, the instruction itself, and measuring results. Therefore, while planning for teaching and especially in studying effectiveness of two or more methods, these five processes must be considered by the investigators. Planning is anticipatory decision making. It involves deciding what to do and how to do it before any concrete action is taken. Davies (1976) developed different approaches with respect to planning for teaching or curriculum making. He developed these approaches on the basis of ideas put forth by John Dewey, Karl Popper, and Brain Lewis. These three approaches are discussed in brief.

Path X, represents a systematic approach towards teaching and curricular planning. It involves, first, defining the ends or objectives to be achieved and, then, selecting the means or procedures necessary for realizing them. Such a seemingly 'rational' view assumes that you have a very clear idea of the future you wish to command for without such a blue print it is impossible to define in any realistic way the objectives that you wish to reach.
Path Y, on the other hand, represents a more expedient approach towards teaching and curriculum development. Indeed, some people suggest that it comprises an irrational way of planning. At any rate, it involves, first, defining the means or procedures to be used and, then, determining those objectives or ends that will accommodate the limitations or constraints that you have imposed upon yourself. This is a traditional way of planning.

Path Z, involves what Karl Poppen calls, a 'piecemeal approach', which he recommends as methodologically sound without the dangers often implicit in rational planning. Rather than defining either the ends or the means in such a clearcut manner as in the other two paths, a cyclical, if not piecemeal, approach is adopted. This involves successive approximations or increments for which no initial blue-print or master plan is necessary. In following this approach in teaching and development work, one perhaps starts with some rough definition of some more important aims, before considering the resources needed, and then back to a more precise definition of objectives before turning once again to means available etcetera. As a result of this constant turning and recycling backwards and forwards, as more and more information becomes available, a more realistic approach to development and teaching is possible.

These three different approaches are possible for planning teaching. In the context of the present study, the researcher is of the opinion that in order to study the
comparative effectiveness of the two methods, path 'X' systematic planning approach should be adopted. Therefore, in the present investigation systematic planning was done by the researcher. The steps followed in this systematic planning are given below in the figure 5.1.

**Lessons planning**

![Diagram](image_url)

1) Determining objectives and specifications:

Glasser (1966, p. 14) pointed out that, in the design of educational programmes, analysis of terminal objectives to be achieved has been a more influential endeavour than manipulations in methods of teaching, objectives. According to Davies (1977, p. 4), objectives lie at the very heart of
the planning process, whether one is planning a curriculum or a single classroom lesson. Therefore, objectives are more important in the planning process. Specifically, objectives help the teacher in planning for teaching, guide students learning and providing a criterion for evaluating the effectiveness of teaching itself. Educational psychologists have advocated various techniques of stating objectives—the most general source of ideas concerning objectives are taxonomies. The objectives are classified into three domains—cognitive domain, affective domain, and psychomotor domain.

Since the present investigation was limited to the cognitive domain only, the researcher selected objectives from the cognitive domain only. Bloom (1956, p.7) defined cognitive domain as one that includes those objectives which deal with the recall or recognition of knowledge and the development of intellectual abilities and skills. As the study was limited to only one unit and nine periods of teaching, the objectives namely knowledge, comprehension and application, from the cognitive domain were selected for developing lesson plans and measuring instruments by the researcher.

Gronlund (1970, p.6) suggested that stating objectives is a two-step process as follows:

1. to state the instructional objectives as general learning outcomes.

2. to list under each instructional objectives, a representative sample of the specific types of behaviour that indicate attainment of the objectives.
While deciding about objectives and specifications of teaching the unit 'volume', behavioural form of stating the objective was adopted by the researcher. This particular form of stating the objective was chosen by the researcher because i) behavioural objectives use action verbs, ii) behavioural objectives focus on learners' outcomes, and iii) behavioural objectives tend to be more specific. Taking into consideration the various aspects such as nature of the content, grade level of the students, time available for teaching, the detailed list of objectives with specification was prepared which was common to both the methods of teaching expository and guided discovery. The detailed list of objectives with specifications is given in the appendix A.

ii) Content Analysis:

In order to decide about what is to be taught with respect to a particular unit in depth, the content analysis is necessary. By analyzing the content the teacher can define the nature and scope of the unit to be taught. Content analysis, as defined by Anderson et al. (1975, p.82), is a general assessment technique by which complex phenomena can be reduced to simpler terms. Content analysis is termed a 'general' technique because it is modifiable to obtain many kinds of data that an evaluator needs.

If one applies this definition to the content in mathematics, then content analysis will be breaking down the complexity of the subject matter in mathematics to simpler ones. In mathematics, the content can be analyzed into facts,
new terms, concepts, generalizations, and symbols and formulae. The detailed analysis of the content with respect to unit 'volume' was done by the researcher. Content analysis is given in Table No. 5.1 partially. A detailed analysis is given in the appendix B.

<table>
<thead>
<tr>
<th>Element</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Symbols and signs</td>
<td>i, b, h,</td>
</tr>
<tr>
<td>ii) New terms</td>
<td>volume, base, cubic centimeter, cuboid, cube, prism, cylinder</td>
</tr>
<tr>
<td>iii) Formulae</td>
<td>i) In regular solids volume = Area of the base x height.</td>
</tr>
<tr>
<td></td>
<td>ii) Volume of cuboid = l.b.h.</td>
</tr>
<tr>
<td>iv) Generalizations</td>
<td>The volume of the cuboid is equal to the product of length breadth and height of the cuboid.</td>
</tr>
<tr>
<td>v) Concepts</td>
<td>Every cube is a cuboid but every cuboid is not a cube.</td>
</tr>
</tbody>
</table>

iii) Preparation of the lesson-plans:

Lesson plans help the teacher to facilitate the attainment of desired objectives. If the teacher develops the plans appropriately the likelihood of attaining the objectives is greatly increased. Effective lesson planning helps the teacher to lead the pupils in the desired direction and maximum utilization of class-time. Therefore, in order to achieve this, it is necessary to develop lesson plans in detail.
so that the teacher can translate planned behaviours into action while teaching the class. "A lesson plan" in the words of Sand (1967, p.215), "is actually a plan of action. It therefore, includes the working philosophy, her (teacher) information about and understanding of her pupils, her comprehension of the objectives of education, her knowledge of material to be taught, and her ability to utilize effective methods."

Therefore, while developing the lesson plans with respect to expository and guided discovery methods of teaching mathematics, the researcher prepared a detailed account of the plan of action to be implemented by the teacher during the experimental treatment. Lesson plans with respect to these two methods on the unit 'volume' were prepared by the researcher. The total number of lesson plans prepared was eighteen, 9 lesson plans belonging to expository method and 9 to guided discovery method. Every care was taken by the researcher to keep almost all types of learning experiences, types of examples, homework, teaching aids, identical in both the treatments. While developing the lesson plans the following points were taken into account by the researcher:

1) All the lessons related to expository method were based on the sequence of moves: - statement of the rule, followed by clarification of the rule, followed by justification of rule, and followed by application of the rule. This particular sequence was followed in introducing
the new generalization to the students. But at the time of solving the examples based on the generalization taught, justification with respect to all the examples was not given. This resulted in saving of time, unnecessary repetition and also providing opportunity for solving more examples in the class itself.

2) All the lessons related to guided discovery method were based on the sequence of moves - clarification of the principle/rule, followed by justification of the rule, followed by statement of the rule, and followed by application of the rule. This particular sequence was followed at the time of introducing the generalization. The same sequence was followed in solving the examples; however in the case of some examples, justification of the rule was not given. This resulted in saving of time, avoiding of repetition and time for solving more examples. Out of a lessons, three lessons, lesson No. 2nd, 5th and 9th were related to teaching of new generalization. First was volume of cuboid (volume of cuboid = l x b x h), second was volume of cylinder (volume of cylinder = \( \pi \times r^2 \times h \)), and third was volume of triangular prism (volume of triangular prism = \( \frac{1}{2} \times \text{base} \times \text{height} \times \text{height of triangular prism} \)). Out of these three generalizations, first generalization (volume of cuboid) was planned to be taught by inductive discovery method through enactive mode: students were given opportunity to do the experiment and discover the relationship. Second generalization volume of cylinder was planned to be taught by deductive discovery method through inductive mode: The formula of volume of cylinder
was deduced from the formula, 'volume = area of the base x height' by using teacher demonstration (ikonic mode). The third generalization was planned to be taught by deductive discovery which was deduced from the formula, 'volume = area of the base x height' where teacher used only symbolic representation.

Since inductive teaching takes lot of time, in order to utilize maximum time for discovery to be made, the above strategy was adopted by the researcher. Secondly, these three generalizations taught during the experimental treatment were interrelated, by adopting deductive discovery method all the three modes representation: enactive, ikonic, and symbolic were used while teaching. Thirdly, in order to know whether grade VII pupils can discover through all these three modes of representation, this method of introducing the generalization was adopted.

3) All the lessons related to both the methods were based on two principles, (i) concrete to abstract, and 2) simple to complex.

4) The first generalization: volume of cuboid was planned to teach by enactive mode, i.e. giving opportunity to students to manipulate the objects directly by themselves. Second generalization by ikonic mode, where teacher demonstrated the experiment with objects, and third by symbolic mode where teacher used mainly symbols in introducing the generalization. Although this particular sequence of moves reduced
the amount of pupil participation actively and physically, this resulted in providing learning experiences from concrete to abstract gradually. Abstract thinking is also essential in the study of mathematics, and therefore, this particular sequence was adopted.

5) Questions to be asked during the teaching process, expected answers to these questions from the pupils, verbal and nonverbal activities of both the teachers and pupils, special instructions to teacher, all these were taken into account while developing the lesson plans related to both the methods.

6) Examples to be solved in the class during the experimental treatment were prepared on the principle of 'simple to complex' and to strengthen the understanding of the generalization taught in the class. There was gradual increase in complexity of the examples based on comprehension, and application objectives. These examples were common to both the methods. These examples were cyclostyled and used during the instructional periods in order to save time in writing these on chalkboard by the teacher or by the students in their note-books. This facilitated the maximum use of time for instructional purposes only.

7) In order to control the effect of homework on the achievement of the students with respect to both the treatments, home-assignments were prepared on each of the lessons taught and these were cyclostyled and given to the students on the
first day of the experiment. The students were given notebooks by the researcher, in which the students were instructed to solve these examples. These examples were developed on the 'principle of parallelism' i.e. examples on each of the lesson were similar/parallel to examples solved in the class, so that students should not find any difficulty in solving these at home. Secondly, students should get enough practice to solve examples on the principles learnt during the experiment.

iv) Preparation of the hardware:

It is needless to point out the importance of hardware/aids in the teaching-learning process. With the help of these aids, the teacher is in a position to teach the content in all the three modes of representation that is, enactive, ikonic, and symbolic. The unit selected for the teaching was volume. The concept of volume is a three-dimensional one. The students who were selected for the experiment were between ages 10 and 13 years. According to the stage of cognitive development, they were in the state of concrete-operational level. Wallace (1966, p.112) pointed out that according to Piaget the child is ready for attaining conservation of volume at the age 11 to 12 years of age, because from a maturational point of view it requires concrete operations, which are present in most children by the age of 7 years, and from the point of view of experience, he has had sufficient object contacts to develop conservation of mass and weight, and structural prerequisites for the attainment of volume.
conservation. Therefore, the researcher felt a strong need for developing the hardwares to be used by the teacher during the experimental treatment. The aids which the researcher wanted to use were not available either in school or at any educational institution. Therefore, the researcher prepared special aids and used some aids from the physics laboratories of the schools involved in the study. While developing the aids, the following points were kept in mind by the researcher.

a) The volume in case of regular solids depends upon area of the base and height of the solids. In order to develop this concept, cuboids, cylinders, and triangular prisms of wood were prepared. While preparing these, care was taken so that students would differentiate both bases and heights from their seat by observing them only. The blocks were painted in different colours so that students could identify them very easily from a distance. The total number of blocks prepared was 18.

b) In order to teach the generalization, volume of the cuboid is the product of length, breadth and height of the cuboid, sixteen sets of five cuboids each were prepared so that each student should get a set of five cuboids. The dimensions of these cuboids were so chosen that it would facilitate the students to generalize the relationship very easily. The cuboids were also painted in different colours so that the teacher would find no difficulty
in giving instruction at the time of the experiment. The students were given opportunity to measure length, breadth and height of the cuboid. The arrangement of the experiment is shown in the Photograph No. 5.1.

c) To offer the justification of the rule, 'volume of the cuboid = length x breadth x height' water displacement method was used. For this, five metallic cuboids were prepared of having exactly the same measurements as the wooden cuboids. Measuring cylinders, overflow vessels, beakers, etcetera were used from the Physics laboratory.

d) In finding out the volume of each cuboid, cubes having volume 1 cm$^3$ were used to construct the cuboid. These cubes were taken from the Physics laboratory.

e) In introducing the relationship between circular base and cylinder, small circular discs were used by the teacher from which cylinder could be constructed. This resulted in deducing the rule 'volume of the cylinder = $\pi \times r^2 \times h$' from the rule, 'volume = area of the base x height.'

f) For comprehension objective, students were given some blocks of cuboid, cube, cylinder, and triangular prism. The students were asked to measure the dimensions of these blocks and to construct the examples, which were solved by them subsequently.

g) For application objective, some special type of wooden blocks were prepared which are given in the form of diagram in the class-work and homework sheets.
Arrangement of the experiment

Photograph no 5.1
Arrangement of the experiment

Photograph no 5.1
Details about measurements, number of blocks and types of blocks are given in the appendix (c).

v) Discussion of the lesson plans with the experts:

The first draft of the lesson plans of both the methods was shown to three expert teacher educators and these were thoroughly discussed with them. One teacher educator suggested to keep the number of questions same, in all the lesson plans belonging to each of the two methods based on the same content. This particular suggestion was accepted by the researcher because, there should not be much difference between interaction patterns of both the methods at least at the planning stage. In the light of this suggestion all the lesson plans with respect to both the methods were modified by the researcher. In some lessons, especially, with respect to expository method, it was difficult to increase the number of questions, then the researcher decided to ask the teacher to repeat wherever necessary some of the important questions so that incidently interaction patterns of both the methods would be the same at the planning stage.

vi) Final draft of the lesson plans:

Taking into consideration all the points mentioned in the sections 5.1(i) through 5.1(v) the detailed lesson plans were prepared. The total number of lesson plans prepared was eighteen, nine belonging to the expository and 9 to the guided discovery method. The details were filled in a suitable proforma which contained the following points:
(a) Instruction to the teacher in regard to the use of aids.
(b) Content to be taught.
(c) Teacher activities both non-verbal and verbal along with specific questions to be asked.
(d) Student activities both verbal and non-verbal.
(e) Moves of the method indicating time required for each of the move.

A detailed copy of each of the lesson plan with respect to both the methods is given in the appendix D.

5.2.0 PREPARATION OF THE MEASURING INSTRUMENTS:

Two sets of measuring instruments were constructed by the researcher. One set contained observation proformas and the second set was related to achievement tests. The details about these two measuring instruments are given in this section.

1) Observation proformas:

The main purpose of developing these observation proformas was to supplement the information obtained from the audiotapes of the teaching process with respect to non-verbal activities in the classroom.

The first proforma was related to time distribution of non-verbal activities which had two dimensions. One dimension was related to specific non-verbal activities that were planned and second related to time. The proforma is shown in Figure 5.2.
<table>
<thead>
<tr>
<th>Activity</th>
<th>A</th>
<th>C</th>
<th>D</th>
<th>Time in Minutes</th>
<th>Total Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Observes Teachers' demonstrations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>silently</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii) Reading examples</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>silently</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iii) Calculates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iv) Takes down</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>v) Experimenting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vi) Counts Cubes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vii) Takes measures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of objects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>viii) Draws figures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ix) Solves examples</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>independently</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>x) Any other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. No. 5.2
Observational proforma
The second proforma was related to chalkboard work.

The proforma is shown in Figure 5.3.

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**CHALK-BUILD WORK OBSERVATION SCHEDULE**

<table>
<thead>
<tr>
<th>Date : ________</th>
<th>Lesson : ________</th>
<th>VII A[ ]</th>
<th>C[ ]</th>
<th>D[ ]</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Time (in minutes)</th>
<th>Left hand column</th>
<th>Right hand column</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 - 14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 - 21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 - 28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28 - 35</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 5.3 : Chalkboard observational schedule

On the vertical axis there were seven rows related to each of five-minute interval and on the horizontal axis there were two columns, each column representing the two columns of the chalk board.

These two proformas were planned to be filled in by two different observers during the experimental treatment. One was used by the researcher and the other one was used by a trained observer.

ii) Achievement Tests:

Achievement tests are of two types, standardized achievement tests and teacher-made achievement tests. As
standardized tests based on the VII grade syllabus in mathematics were not available in general, and test on 'volume' in particular, the researcher decided to construct the post test based on the unit 'volume', for testing the effectiveness of the two methods.

As pointed out in section 1.5.0, it was decided to take pre-achievement of the student as covariate at the time of analysis in order to control the effect of pre-achievement on subsequent achievement. Standardized test based on previous knowledge required for the unit 'volume' was also not available. Therefore, the researcher also constructed the pre-achievement test. Secondly Schwartz and Tiedman (1957, p.110) stated that teacher made tests are valuable because they assess the extent and degree of student progress with reference to specific classroom activities. Therefore, the researcher constructed these two tests. But while constructing the tests, in order to avoid the drawbacks of the teacher made test such as ambiguous questioning, excessive wording, lack of appropriate emphasis, and use of inappropriate formats, a systematic procedure of test construction was adopted. This procedure is given in the form of Figure 5.4.
a) Pre-achievement test:

A suitable standardized test on previous knowledge required for the learning of unit 'volume' that could be used in the experiment was not available. Therefore, a pre-achievement test in mathematics was constructed. The content covered in this test was area of the square, rectangle, circle, and square and square root of the integers up to two decimals. This particular content is the pre-requisite knowledge for the learning of the unit 'volume'. The three types of test items were prepared taking into consideration the nature of the
content, objectives of instruction, time available and familiarity of the students with different types of test items. The types of items included in the test were essay, short answer, and multiple choice. The blue-print of the pre-achievement test is given in the table below.

Table 5.2: showing blue-print of the pre-achievement test

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Content</th>
<th>Objectives</th>
<th>Total marks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Knowledge</td>
<td>Comprehension</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E. S. O.</td>
<td>E. S. O.</td>
</tr>
<tr>
<td>1.</td>
<td>Concept of area</td>
<td>-</td>
<td>2(2)</td>
</tr>
<tr>
<td>2.</td>
<td>Area of rectangle square</td>
<td>-</td>
<td>4(4)</td>
</tr>
<tr>
<td>3.</td>
<td>Area of the circle</td>
<td>-</td>
<td>3(3)</td>
</tr>
<tr>
<td>4.</td>
<td>Square-root:Square</td>
<td>-</td>
<td>1(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>10(10)</td>
<td>6(12)</td>
</tr>
</tbody>
</table>

Figures in the bracket denote marks assigned to items.

* Two items were based on the content, area of square and area of circle.

In order to make the essay and short answer questions more objective and clear to students, specific points were included in the test itself, so that students were expected to write the answers on the points mentioned in the test itself.

A copy of the test is given in the appendix-E.
b) Post-achievement test:

A suitable standardized test based on unit 'volume' from the VII grade syllabus in mathematics that could be used in the experiment was not available. Therefore, a test based on unit 'volume' from the syllabus of VII grade mathematics was constructed. It covered the content such as concept of volume, volume of the cuboid, cube, cylinder, and triangular prism. This particular content was taught during the experimental treatment. Keeping in view the objectives of teaching the unit 'volume', the post-test was constructed. The test consisted of essay, short answer and multiple choice test items. The selection of all these three different types of items was based on considerations such as grade-level of the students, subject matter taught, objectives of teaching, familiarity of the students with respect to different types of items. The blue print of the post-test is given in table 5.3.

Table 5.3 : showing blue print of the post-test:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Content</th>
<th>Objectives</th>
<th>Total Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Knowledge</td>
<td>Comprehension</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E. S. O.</td>
<td>E. S. O.</td>
</tr>
<tr>
<td>1</td>
<td>Volume-Concept</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Volume of Cuboid, Cube</td>
<td></td>
<td>3(3)</td>
</tr>
<tr>
<td>3</td>
<td>Volume of Cylinder</td>
<td></td>
<td>4(4)</td>
</tr>
<tr>
<td>4</td>
<td>Volume of triangular prism</td>
<td></td>
<td>1(1)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>10(10)</td>
<td>10(15)</td>
</tr>
</tbody>
</table>

Figures in the bracket denote marks assigned to items.
In order to make the essay and short answer type items more objective and clear to students, specific suggestions were included in the test itself, so that students should write the answers in the light of points mentioned in the test itself. A copy of the test is given in Appendix F.

5.3.0 TRAINING OF THE TEACHER

A mentioned in Section 3.2.0 in order to control the inter-teacher variability, it was decided to use only one teacher teaching all the six groups involved in the study. As per year plan of both the schools, in one school the unit 'volume' was to be taught in the month of November and in the other school it was in the month of January. Therefore, the researcher decided to train the teacher in two phases also. Training with respect to expository method was completed in the last week of October and the first week of November. Training with respect to guided discovery method was completed in the last week of December and the first week of January.

Both the training programmes were conducted prior to the actual teaching by the teacher. Due to this particular situation, the teacher had to teach only three lessons per day by the same method, therefore, intra teacher variation with respect to both the methods was minimum. The details about selection and training are given in the subsequent section.

i) Selection of the teacher:

The researcher is of the opinion that in selecting the 'live teacher' in research on teaching some specific criteria must be applied. In the present investigation, the following criteria regarding selection of teacher were adopted.
a) who could easily be programmed.
b) who had experience of teaching the particular standard selected for the study.
c) who had undergone training with respect to probing questioning. This particular skill was very essential in guided discovery method.
d) who was basically interested in teaching and who was ready to participate willingly.

Taking into consideration the above criteria, the researcher contacted 2-3 teachers after discussing with them, the researcher finally selected 'the teacher'. The selected teacher had the following presage variables:

- percentile rank of intelligence - P95
- teacher attitude score - 260
- degree marks - 55.0%
- B.Ed : I (distinction) - 70.6
- M.Ed : I Class - 68%

ii) Training with respect to expository method:

While giving training to the teacher, specific instructions were given, which were as follows:

a) The teacher should act as a primary source of knowledge.
b) The teacher should show the students how to solve the problem correctly if the students are unable to solve it correctly.
c) Negative evaluation of the student's response should be avoided.

d) The teacher should give the generalization before the student's are given any examples; all examples are then related back to the rule for solution.

e) The teacher should answer questions by reiterating and explaining the rule and relating it to the questions.

f) Students should be allowed to do examples themselves independently.

g) The teacher should warn the students of common errors made in applying the rule.

h) The teacher should point out specifically the types of problems in respect of which the students are likely to make errors and then gives illustrations of each kind of error.

The above mentioned points were used by Worthen (1970, p.138) in training the teachers involved in his study. By keeping in view these general points, the researcher discussed each and every lesson plan with the teacher. Every day one lesson plan was discussed and this training programme continued for ten days, one hour each day. During the experimental period also, after completion of the daily teaching the next lesson was discussed in brief and doubts which were raised, were discussed and clarified.
iii) Training with respect to guided discovery method:

To train the teacher with respect to guided discovery method, the following general instructions were given:

a) The teacher should not act as the primary source of knowledge, but should seem to depend upon the students to help her work the problems.
b) She should reflect uncertain feeling about the precise way to solve a particular problem.
c) When students give answers correct or incorrect, the teacher should check it by the long method as if she is not aware of the principle that would enable for solution by a student.
d) When students give incorrect answers, she should proceed as if she does not know, and if students point out the incorrectness of the answers, she should be surprised.
e) The student who gives a wrong response, should be given an opportunity to correct it, if he is unable to do so other members of the class should be asked to respond.
f) The teacher should delay the verbalization of the generalization until all, or nearly all, of the students make the discovery.
g) The teacher should answer questions by referring to the model or computational sequence the students will be using, if students appeared to be still confused, the teacher should take them back to the model and should ask them to go through it carefully.
h) The teacher can make the use of sequenced example as a clue, but no verbal hint of the rule should be given. Probing questioning skill should be used by the teacher in such situations.

i) The teacher should ask trap questions and should give no verbal warning of any type.

The above mentioned points were used by Worthen (1970, p.139) in training teachers involved in the study. By keeping in view these general points, the researcher discussed each and every lesson plan of guided discovery method with the teacher. Every day only one lesson plan was discussed and this training programme continued for thirteen days, one hour each day. During the experimental treatment also, after completion of daily teaching the next lesson was discussed in brief and doubts which were raised by the teacher were discussed and clarified.

5.4.0 CONDUCT OF THE EXPERIMENT:

In order to control the contamination between two treatments, two different schools situated at different places were selected by the researcher. The selection of the schools is already described in the section 3.2.0. The names of the school were His Highness Chintamanrao Patwardhan High School (HHCP High School) and Kenuka Swaroop Memorial High School (KSM High School). As per plan of HHCP high school, unit 'volume' was in the month of November and in KSM high school, in the month of January. Therefore, the experiment was conducted in two phases, expository method in HHCP high school and
guided discovery method in RSM high school. This particular sequence was followed for the sake of convenience and ease in training the teacher. The details about the time table are given in the next sections.

1) Preparation of the time table:

As per conditions of both the schools, the researcher had to follow the regular time table of the school while preparing the time table for the experiment. There were seven periods per week allocated to VII grade mathematics. All the seven lessons were not engaged for the experiment because the teacher involved in the experiment would have required to teach more than three periods per day since three divisions VII A, C, D were engaged. Therefore, out of two continuous periods on one day per week, only one period was engaged, and secondly there would have been difference in sequence of teaching with the same method to all the three classes. Therefore, the researcher decided to engage 6 lessons per week, that is, one lesson for each division per day. The remaining seventh lesson was engaged by their regular teacher. But regular teachers were requested not to teach any content from unit 'volume' during that period. The detailed time table of experiment with respect to both the schools is given in appendix -G.

ii) Instruction to teachers and students:

Since both the schools were having 8-9 divisions of grade VII, the researcher felt the need of giving information and instructions about the experiment to teachers teaching
mathematics to grade VII from both the schools. The researcher convened a meeting of the teachers from both the schools separately and teachers were given detailed time table, lesson notes duly typed, class work, and home work. Care was taken not to give either pre-test or post-test to them. This might have affected the results of the experiment. These teachers were requested to strictly adhere to the time table and teach particular subunits as per plan given to them. The teachers from the experimental classes that is VII A, VII C & VII D were requested to send the students chosen for the experiment to the special classroom. A list of students selected for the experiment was also given to these teachers. It was due to the excellent co-operation from the teachers that the experiment completed smoothly without any disturbance of any kind.

For the students who were selected for the experiments, it was a first experience of this kind to them as far as the experiment related to teaching of mathematics was concerned. Majority of the students were willing to participate in the experiment but these students were selected and mentioned in section 3.2.0. The researcher gave instructions orally first in common to students. Many students raised some doubts with respect to the experiment, especially whether the marks would be included in the result sheet or not. After attending to their queries and doubts the researcher gave detailed instructions duly cyclostyled, time-table of the experiment and note books to solve examples for home work. The researcher
requested them to extend their cooperation and told them to feel free at the time of experiment. A sheet containing instructions to students is given in the appendix (H).

iii) Pre-achievement Test:

One week prior to the actual teaching in the experiment, the teachers from the experimental classes were requested to take revision on the content which was prescribed for the pre-achievement test. The pre-achievement test was administered to all three classes at a time on Saturday. The test consisted of essay, short answer and multiple choice items. The marks allotted for the test were 50 and the duration 1½ hours. It was found that the time allotted to students for answering was enough.

iv) Seating arrangement during the experiment:

Out of 55-60 students from VII A, VII C, VII D, only 16 students from each division were selected and taught separately in a special class room provided by the school authorities. The seating arrangement was altogether different from normal classroom seating arrangement. The main considerations in changing the seating arrangement were, (i) to record verbal interaction between teacher and the students maximally, (ii) to distribute the teaching aids, class assignment sheets easily, (iii) ease in movement of the teacher in the class, (iv) to facilitate viewing of teacher's demonstrations during the teaching process by all the students without any difficulty, and (v) to facilitate
doing of experiment without any difficulty by providing big

All the students were instructed to occupy the same

tables and chairs to the students.

seat throughout the 9 periods of experimental teaching.

Seating arrangement is shown in the photograph No.5.2

v) Teaching and Observation of teaching:

All the six classes were taught by the same teacher by
two methods. The total number of lessons taught by the teacher
was 54. Three lessons per day were taught by the teacher,
therefore, the experiment continued for 18 days. All the
lessons given by the teacher were audiotaped by using two
microphones connected through mixer to the tape-recorder.
An alternate arrangement of battery system was also made,
in case of failure of the power during the experimental
treatment. Non verbal activities were observed by one observer
using proforma for non-verbal activities and all the chalkboard
work was taken down by another observer in a proforma specially
developed by the researcher.

Expository teaching was completed in the month of
November 1981 in H.H.G.P. high school and guided discovery
teaching in the month of January 1982 in R.S.M. high school.

vi) Fidelity of the treatment:

Medley and Mitzel (1963, p.249) criticised researches

on teaching, "the classic design does not involve any observa-
tion of the teaching either class to find out whether - and to
Seating arrangement

Photograph no 5.2
what degrees the method supposed to be applied actually is applied." Therefore, in determining the fidelity of the treatment method direct observation plays an important role.

Fidelity means the degree to which a particular method is adopted in the classroom. No measure of degree of adoption of methods is available by which one can measure the degree of either expository or guided discovery method. This is to say that method is a qualitative variable. In guided discovery, the sequence is ordinarily clarification of the rule - justification of the rule - statement of the rule - application of the rule. There is no clearcut evidence with respect to whether justification of the rule is to be followed by statement of the rule or statement of the rule followed by justification of the rule. But on one point all the investigators have agreed that in guided discovery method clarification of the rule is the initial move.

In the present investigation it was decided to analyze the transcripts of the recorded lessons and to determine what type of sequence was followed in lesson Nos. 2nd, 5th, 9th where a generalization was taught in case of both the methods. The sequence followed in each of these lessons with respect to all the six groups involved in the study is given in the subsequent chapter.

vii) Administration of post-test:

After conclusion of 9 day's teaching in each of the school, the post test based on the unit taught during the
experiment was administered to the students on the following day in both the schools. In order to measure the effect of these two methods on retention, the same test was administered after three weeks of the conclusion of this experiment.

viii) Scoring of answerscripts:

Pre-achievement and post tests consisted of multiple choice test items as well as essay and short answer questions. Therefore, scoring key for multiple choice test items and detailed marking scheme for essay and short answer questions were prepared. The researcher scored answerscripts of all the students by using scoring key and marking scheme. Care was taken by the researcher to assess these answer scripts objectively and reliably by assessing these scripts twice after a gap of fifteen days in between two assessments.

ix) Experimental Mortality:

In any piece of research, there exists experimental mortality and especially so in research on teaching. This mortality of subjects may be due to non-attendance during the experimental teaching, absence for either pre and/or post tests and so on. In the present investigation also, out of 96 students who participated in the experiment, the researcher could collect the data with respect to 72 students only. Data in respect of following type of students was rejected on the basis of following criteria: -
a) the students who were absent for more than one teaching period out of 9 periods.

b) the students who were either absent for pre-achievement or post-achievement tests.

c) the counter parts of students who were deleted due to reasons (a) and (b) were also not included in this final analysis because it would have created unequal cell frequencies which may lead to difficulties at the time of analysis.

Considering the above points, the scores of 72 students were analyzed by using an analysis of covariance technique which is discussed in next chapter.