CHAPTER THIRD

PLAN AND PROCEDURE OF THE RESEARCH

3.0 INTRODUCTION:

In the previous chapter, researcher has given a brief account of the related literature and research studies. Existing literature and the several studies, which points out that the problem chosen by the researcher has roots in the existing literature, but further exploration is needed in this field. Hence the researcher developed Mathematics Experiment Notebook to teach Mathematics to Upper Primary classes.

This chapter deals with the preparatory phase of the experiment which contains development of Mathematics Experiment Notebook for teaching upper primary classes, development of other tools, determination of the period, the time schedule of the experiment and the plan and procedure of their execution.

The second section of this chapter deals with Experimental phase which contains Consent of authorities, Research Procedure, Research Design, Sampling procedure, tryout and group formation.

The last section of this chapter deal with the Post-Experimental Phase which was concerned with the information about the data producing tools employed in the study.

3.1 RESEARCH METHOD:

The researcher used the research procedure in developing Mathematics Experiment Notebook for teaching Upper Primary classes.

The researcher collected data and analysed on the following basis.

1. Analysis of questionnaire of experienced Mathematics school teachers for present position of teaching Mathematics. (Appendix C)

2. Analysis of opinionnaire about Mathematics Experiment Notebook by experienced school teachers. (Appendix H)

4. Analysis of questionnaire about Mathematics Experiment Notebook by research experts. (Appendix I)

5. Analysis of Curriculum Clarity Format about checking the MEN by research experts. (Appendix J)

6. Suggestions given by research experts.

3.1.1 **FLOW CHART OF RESEARCH:**

The researcher has shown the flow chart of research procedure in following way.

```
Research Method
↓
Sample Selection
↓
Variables
↓
Preparation of Tools
↓
Pilot Study
↓
Main Study
↓
Collection of Data
↓
Analysis and Interpretation
↓
Findings of Research
```

Fig.3.1

Flow Chart of Research

3.1.2 **SELECTION OF RESEARCH METHOD:**

There are many types of educational research and there are also a number of ways in which they may be classified. Studies may be classified according to topic
whereby the particular phenomena being investigated are used to group the studies. Some examples of educational research topics are: teaching methods, school administration, classroom environment, school finance, etc. Studies may also be classified according to whether they are exploratory or confirmatory.

An exploratory study is taken in situations where there is a lack of theoretical understanding about the phenomena being investigated so that key variables, their relationships, and their (potential) causal linkages, are the subject of conjecture. In contrast a confirmatory study is employed when the researcher has generated a theoretical model (based on theory, previous research findings, or detailed observation) that needs to be tested through the gathering and analysis of field data.

A more widely applied way of classifying educational research studies is to define the various types of research according to the kinds of information that they provide. Accordingly, educational research studies may be classified as follows:

1. **Historical research** generates descriptions, and sometimes attempted explanations, of conditions, situations, and events that have occurred in the past. For example, a study that documents the evolution of teacher training programmes since the turn of the century, with the aim of explaining the historical origins of the content and processes of current programmes.

   The historical method comprises the techniques and guidelines by which historians use historical sources and other evidence to research and then to write history. There are various history guidelines commonly used by historians in their work, under the headings of external criticism, internal criticism, and synthesis. This includes lower criticism and sensual criticism. Though items may vary depending on the subject matter and researcher, the following concepts are usually part of most formal historical research.

2. **Descriptive research** provides information about conditions, situations, and events that occur in the present. For example, a survey of the physical condition of school buildings in order to establish a descriptive profile of the facilities that exist in a typical school. Descriptive research seeks to depict what already exists in a group or population. An example of this type of research would be an opinion poll to determine which Presidential candidate people plan to vote for in the next election. Descriptive studies do not seek to measure the effect of a variable; they seek only to describe.
3. Co-relational research involves the search for relationships between variables through the use of various measures of statistical association. For example, an investigation of the relationship between teachers’ satisfaction with their job and various factors describing the provision and quality of teacher housing, salaries, leave entitlements, and the availability of classroom supplies.

4. Causal research aims to suggest causal linkages between variables by observing existing phenomena and then searching back through available data in order to try to identify plausible causal relationships. For example, a study of factors related to student ‘drop out’ from secondary school using data obtained from school records over the past decade.

5. Experimental research is used in settings where variables defining one or more ‘causes’ can be manipulated in a systematic fashion in order to discern ‘effects’ on other variables. For example, an investigation of the effectiveness of two new textbooks using random assignment of teachers and students to three groups – two groups for each of the new textbooks, and one group as a ‘control’ group to use the existing textbook.

   The experimental method involves manipulating one variable to determine if changes in one variable cause changes in another variable. This method relies on controlled methods, random assignment and the manipulation of variables to test a hypothesis.

6. Case study research generally refers to two distinct research approaches. The first consists of an in-depth study of a particular student, classroom, or school with the aim of producing a nuanced description of the pervading cultural setting that affects education, and an account of the interactions that take place between students and other relevant persons. For example, an in depth exploration of the patterns of friendship between students in a single class. The second approach to Case Study Research involves the application of quantitative research methods to non-probability samples – which provide results that are not necessarily designed to be generalisable to wider populations. For example, a survey of the reading achievements of the students in one rural region of a particular country.

7. Ethnographic research usually consists of a description of events that occur within the life of a group – with particular reference to the interaction of
individuals in the context of the socio-cultural norms, rituals, and beliefs shared by the group. The researcher generally participates in some part of the normal life of the group and uses what he or she learns from this participation to understand the interactions between group members. For example, a detailed account of the daily tasks and interactions encountered by a school principal using observations gathered by a researcher who is placed in the position of ‘Principal’s Assistant’ in order to become fully involved in the daily life of the school.

**8. Research and development research** differs from the above types of research in that, rather than bringing new information to light; it focuses on the interaction between research and the production and evaluation of a new product. This type of research can be ‘formative’ (by collecting evaluative information about the product while it is being developed with the aim of using such information to modify and improve the development process). For example, an investigation of teachers’ reactions to the various drafts and redrafts of a new Mathematics teaching kit, with the information gathered at each stage being used to improve each stage of the drafting.

The researcher selected Experimental study as he wanted to find out the effect of Mathematics Experiment Notebook on the achievement scores of the students.

**3.1.3 EXPERIMENT:**

The experiment was conducted within one month, the procedure of which is explained in the following manner.

The researcher selected randomly two secondary schools i.e. (1) Annasaheb Kalyani Vidyalaya, Satara, Dist. Satara and (2) Maharaja Sayajirao Vidyalaya, Satara Dist. Satara. Out of the students in VI, VII and VIII classes were called randomly for the experiment. 60 students from each class of both schools were the sample of the study. The researcher considered the equivalent group of 30 students from each class (VI, VII and VIII) of Annasaheb Kalyani Vidyalaya, Satara and Maharaja Sayajirao Vidyalaya, Satara as a control group. The equivalent group of 30 students from each class (VI, VII and VIII) of Annasaheb Kalyani Vidyalaya, Satara and Maharaja Sayajirao Vidyalaya, Satara as an experimental group.

The researcher administered a pre-test on half of both the groups of students i.e. 15 students and gave a treatment of developed Mathematics Experiment
Notebook to experimental groups; the control groups were treated with traditional system. He then administered a post-test on both the groups and compared the results.

Is the developed Mathematics Experiment Notebooks used in experimental group of students proved helpful to the students from the group? was a question to be answered. A comparative analysis and interpretation of the gains both in achievement was to answer the question.

Conclusions were drawn about the effectiveness of the developed Mathematics Experiment Notebook and suggestions were stated.

3.1.4 EXPERIMENTAL DESIGN:

Experimentation is the most scientifically sophisticated research method. It is defined as observation under controlled conditions. It studies observable changes that take place in order to establish a cause and effect relationship. It is the description and analysis of what will be occurring or what can be made to occur under carefully controlled conditions.

Experimentation provides a method of hypothesis testing. Although the experimental method finds its greatest utility in the laboratory, it has been effectively applied within non-laboratory settings such as the classroom, where significant factors or variables can be controlled to some degree. The immediate purpose of experimentation is to predict events in the experimental settings. The ultimate purpose is to generalize the variable relationships so that they may be applied outside the laboratory to a wider population of interest. (J. W. Best: 2011 pp 164)

Campbell and Stanley (1966) are of the opinion that, "The experiment is the only means for setting disputes regarding educational practice, the only way of verifying educational improvements."

An experiment involves the comparison of the effects of a particular treatment with that of a different treatment or of no treatment. In a simple conventional experiment, reference is usually made to an experimental group and to a control group. These groups are equated as nearly as possible. The experimental group is exposed to the influence of the factor under consideration; the control group is not. Observations are then made to determine what difference appears or what change or modification occurs in the experimental as contrasted with the control group.
Experimental design is the blueprint of the procedure that enables the researcher to test the hypothesis by reaching the valid conclusions about relationship between dependent and independent variables.

Prof. Fisher* has enumerated three basic principles of experimental design.

- Replication
- Randomisation
- Local Control

* http://kish.in/basic_principles_of_experimental_design/

(Soti Shivendra Chandra and Sharma Rajendra, 2002 pp 353)

True experimental designs have the highest level of control among the three single-variable experimental designs because the subjects within the groups are randomly assigned for each group. When subjects are randomly assigned, there is higher control of the internal validity as well as the external validity. Moreover, there is always a control group to compare the results of the subjects in the experiment with other subjects of similar status that have not been exposed to the treatment.

True experimental research may be designed with or without a pretest on at least two groups of randomly assigned subjects. The classification of true experimental designs is made accordingly.

1. Pre-Experimental Designs
   i. The One-shot Case Study
   ii. The One-Group Pretest-Posttest Design
   iii. The Static-Group Design

2. True Experimental Designs
   i. The Posttest Only, Equivalent-Groups Design
   ii. The Pretest-Posttest Equivalent-Groups Design
   iii. The Solomon Four-Group Design

3. Quasi-Experimental Designs
   i. The Pretest-Posttest Nonequivalent-Groups Design
   ii. The Time-Series Design
   iii. The Equivalent Time-Samples Design
   iv. The Equivalent materials, Pretest, Posttest Designs
   v. Counterbalanced Designs
There were 11 designs presented in three categories. The Pre-Experimental Design was least effective, for it provides either no control group or no way of equating the groups that were used. The True Experimental Designs employs randomization to provide for control of the equivalence of groups and exposure to treatment. The Quasi-Experimental Design provides a less satisfactory degree of control, used only when randomization was not feasible. Out of these designs have some strengths and weaknesses. These are shown in the following table.

**TABLE 3.1**

* SOURCES OF INVALIDITY FOR DESIGNS *

<table>
<thead>
<tr>
<th>Sources of Invalidity for design 1 to 6</th>
<th>Internal</th>
<th>External</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>History</td>
<td>Maturation</td>
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<tr>
<td>Pre-Experimental Designs:</td>
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<tr>
<td>1. One-Shot Case Study</td>
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<td>X O</td>
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<td>2. One-Group Pretest–Posttest Design</td>
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<td>O X O</td>
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<tr>
<td>3. Static-Group Comparison</td>
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<tr>
<td>True Experimental Designs:</td>
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<tr>
<td>4. Pretest–Posttest Control Group Design</td>
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<td>R O X O</td>
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<tr>
<td></td>
<td>R O O</td>
<td></td>
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<tr>
<td>5. Solomon Four-Group Design</td>
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<tr>
<td></td>
<td>R O X O</td>
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<td>R O O</td>
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<tr>
<td></td>
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<tr>
<td></td>
<td>R O</td>
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<tr>
<td>6. Posttest–Only Control Group Design</td>
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<td>R X O</td>
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Sources of Invalidity for Quasi-Experimental Designs 7–12

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<td>Mortality</td>
<td>Mortality</td>
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<td>Interaction of Selection and Maturation, etc.</td>
<td>Interaction of Selection and Maturation, etc.</td>
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<td>Reactive Arrangements</td>
<td>Reactive Arrangements</td>
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<tr>
<td>Multiple-X Interference</td>
<td>Multiple-X Interference</td>
</tr>
</tbody>
</table>

| Quasi-Experimental Designs:                  |                                               |
| 7. The Pretest-Posttest                     |                                               |
| Nonequivalent-Groups Design                 |                                               |
| O₁ X O₂                                     |                                               |
| O₃ C O₄                                     |                                               |
| 7. Time Series                               |                                               |
| O O O O X O O O O                           |                                               |
| 8. Equivalent Time                          |                                               |
| Samples Design                               |                                               |
| X₁O X₁O X₂O, etc.                           |                                               |
| 9. Equivalent Materials                     |                                               |
| Samples Design                               |                                               |
| MaX₁O Mb X₂O McX₁O Md X₃O, etc.              |                                               |
| 11. Counterbalanced Design                   |                                               |
| X₁O X₂O X₃O X₄O                             |                                               |
| X₂O X₃O X₄O X₁O                             |                                               |
| X₂O X₃O X₄O X₁O                             |                                               |
| X₄O X₃O X₂O X₁O                             |                                               |

Note: In the table, a minus indicates a definite weakness, a plus indicates that the factor is controlled, a question mark indicates a possible source of concern, and a blank indicates that the factor is not relevant. It is with extreme reluctance that these summary tables are presented because they are apt to be “too helpful and to be depended upon in place of the more complex and qualified presentation in the text. No + or – indicator should be respected unless the reader comprehends why it is placed there. In particular, it is against the spirit of this presentation to create uncomprehended fears of, or confidence in, specific designs.

Out of the above types of designs researcher selected the Solomon four-group design for this research. Because *Solomon Four-Group Design* takes the effect of pretest and posttest into consideration. It is the combination of the two two-group
designs, the posttest only and the pretest-posttest. In this case, groups are randomly selected and placed into four groups;

<table>
<thead>
<tr>
<th>Solomon Four-group Design</th>
<th>O1 - Exp.</th>
<th>O2 – Control</th>
<th>O3 - Exp.</th>
<th>O4 - Control</th>
</tr>
</thead>
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<td>Random Assignment</td>
<td>Random Assignment</td>
<td>Random Assignment</td>
</tr>
<tr>
<td>2</td>
<td>PRETEST</td>
<td>------</td>
<td>Treatment</td>
<td>Treatment</td>
</tr>
<tr>
<td>3</td>
<td>Treatment</td>
<td>------</td>
<td>Treatment</td>
<td>------</td>
</tr>
<tr>
<td>4</td>
<td>POSTTEST</td>
<td>POSTTEST</td>
<td>POSTTEST</td>
<td>POSTTEST</td>
</tr>
</tbody>
</table>

**Fig. 3.2**

**Solomon Four-Group Design**

### 3.2 RESEARCH DESIGN:

The researcher decided to use the **Solomon Four-Group Design** for main study to test the effect of the revised MEN because it provided equivalency accuracy with less labor and such is a source of economy. The hypothesis formulated by the researcher can be resolved with the help of this design.

\[
R_1 \rightarrow O_1 \rightarrow X \rightarrow O_2 \\
R_1 \rightarrow O_3 \rightarrow C \rightarrow O_4 \\
R_3 \rightarrow X \rightarrow O_5 \\
R_4 \rightarrow C \rightarrow O_6
\]

In this design:

1. On the basis of last semester examination marks, four equivalent groups were made from two different schools.
2. Students were randomly assigned to four groups. There were fifteen (15) students in each group.
3. Two groups received the experimental treatment (X), which was implementation of the revised MEN.
4. One experimental group received a pre-test (O1).
5. Two groups from controlled group did not receive treatment (C), which was implemented traditionally.

6. One control group received a pre-test (O₂).

7. All four groups received post-tests (O₂, O₄, O₅, and O₆).

8. Scores obtained in pre-test and post-test were then calculated, analysed and interpreted.

3.3 SAMPLING DESIGN AND SAMPLE SELECTION:

Sampling procedure involves a number of considerations, which must be clearly understood if adequate results were to be obtained. Most of the educational phenomenon consists of large number of units. Some populations were very large so their study would be expensive in terms of time, effort, money and manpower. Majority of the researches in teacher education were conducted with a limited number of students.

Universe:

Universe population in any group of individuals that have one or more characteristics in common. In this research Upper Primary classes was the common characteristics in the group. All schools having Upper Primary classes were the universe population.

Sample:

A population was composed of the entire group of people that could possibly be included in this study. A sample was a subgroup of individuals selected from that population. Unless the population was small, when conduct the research, researcher could not possibly study every individual within the potential study population, so researcher study a subgroup or sample. As researchers choose a sample for study, they need to make sure that the sample was representative of the larger population. When there was a representative sample, the researcher would be able to generalize to the population. Sampling can save time and money. After research was conducted and researchers determine characteristics of the sample, then generalizations can be made about the entire population. (Johnson and Christensen, 2010, pp.222)
Sample Size –

"The size of the sample becomes important issue because it varies universally as the standard error (SE). The relationship can be stated as larger as "N" (Size of the sample) smaller the "SE". Smaller the "SE" more the dependability of a "M" {mean and 6 (SD)}". (Garret. H.E., 1969, pp.207-208.)

There were very few concrete suggestions regarding the size of the sample. Statistically all samples above N = 30 are treated as large samples.

According to Rescoe, J.J. (1975, pp.184) 10% sample is adequate. Problem of feasibility also needs consideration in deciding the size of the sample.

In the background of above information, the researcher selected the sample. However before that he had to resolve the issue of sample size.

Sample Design:

There are different types of sample design. All the sample designs are based on two factors – the representation basis and the element selection technique. Representation Basis – the sample may be probability sampling or non-probability sampling. The probability sampling is based on concept of random selection and non-probability sampling is non-random selection. Element Selection Basis – the sample may be either restricted or unrestricted. Unrestricted sampling is when each element is drawn individually from the population at large. Restricted sampling is when all other forms of sampling are used.

Thus, sample designs are basically of two types:

1. Probability Sampling
2. Non-Probability Sampling

(C.R.Kothari, 2011, pp 58)

Probability sampling:

A probability sampling method is any method of sampling that utilizes some form of random selection. In order to have a random selection method, you must set up some process or procedure that assures that the different units in your population have equal probabilities of being chosen.
Non-probability sampling:

Non-probability sampling does not involve random selection and probability sampling does. It does mean that non-probability samples cannot depend upon the rationale of probability theory. With non-probability samples, we may or may not represent the population well, and it will often be hard for us to know how well we have done so.

In general, researchers prefer probabilistic or random sampling methods over non-probabilistic ones, and consider them to be more accurate and rigorous.

3.3.1 SAMPLE SELECTION:

a. Universe:

Universe includes all possible respondents of a certain kind. All schools having upper primary classes in Maharashtra with similar geographical, physical and academic conditions.

b. Population: Portion of the universe to which the research has access.

c. The invited sample: All elements of population to which an invitation to participate in research is extended.

d. The accepting sample: It is that portion of invited sample that accepts the invitation and agrees to participate.

e. The data producing sample: The portion of the accepted sample that actually includes data.

Taking in to consideration, the above points, the sampling procedure was completed in three steps as –

1. Experienced school teachers, who were teaching Mathematics to Upper Primary classes from different schools. The experienced school teachers (content experts) selected formed the purposive sampling while the schools were selected by simple random sampling method.

2. Research experts from field of education from five districts i.e. Pune, Nashik, Mumbai, Sangli and Solapur. The research experts selected formed the purposive sampling.
3. The universe for the study was defined as students of Upper Primary classes while the classes and students were selected by simple random sampling method.

The universe has physical boundaries of the State of Maharashtra and it comes in existence through secondary schools. The population of the universe was the students of Upper Primary classes in Maharashtra and this population was accessible for the researcher for the experimentation.

3.3.2 FIRST STAGE POPULATION- SCHOOL:

The researcher used random sampling for selection of two schools from different area in satara. The selected schools were Annasaheb Kalyani Vidyalaya, Satara, and Maharaja Sayajirao Vidyalaya, Satara. These were aided schools. The medium of instruction was Marathi in both the schools.

3.3.3 SECOND STAGE POPULATION- CLASS:

In Annasaheb Kalyani Vidyalaya, Satara (AKVS) has six divisions of each class contains 60 students and Maharaja Sayajirao Vidyalaya, Satara (MSVS) has three divisions of each class contains 60 students. The invitation therefore was given to one division from 2010-2011 batch randomly selected from the population of six divisions in AKVS and one division from the population of three divisions in MSVS.

3.3.4 THIRD STAGE POPULATION- STUDENTS:

All the randomly selected divisions and students from AKVS and MSVS of upper primary classes were accepted the invitation and consented to get involved in the programme me.

The participants accepted the invitation as the researcher earlier appealed to them to share an opportunity to learn with the help of new strategy.

Further the students were made aware that it would be a part of their curriculum. There was no loss in the number of participant students during the experiment. So, the whole accepting sample i.e. sixty students of each class of both the schools from batch 2010-11 became the data producing sample for the study. (Listed in appendices Q1, Q2)
This is shown diagrammatically in following figure.

3.4 VARIABLES:

Variables were the conditions or characteristics that the experimenter manipulates, controls, or observes. The three type’s variables considered in this study and they were located and listed.

1. Dependent variables
2. Independent variables
   i. Attribute variables (age, sex, physical conditions etc.)
3. Confounding variables
   i. Intervening variables
   ii. Extraneous variables

3.4.1 DEPENDENT VARIABLES: The performance of the students in the achievement Tests

The dependent variables were the conditions or characteristics that appear, disappear, or change as the experimenter introduces, removes, or changes independent variables. The dependent variables were achievement of the students in terms of scores and understanding of the Mathematics content related to objectives taken into consideration such as knowledge, comprehension, application and skill. These dependent variables were combined into scores achieved in the pre over post-test by the students i.e. after teaching by MEN and conventional methods.

3.4.2 INDEPENDENT VARIABLES: MEN Prepared by the researcher

Independent variables were inputs. They were measured, manipulated to determine the relationship and they can affect another variable. The independent variable in the present study was MEN prepared for upper primary classes.

The attribute variables were one of the types of independent variables.

3.4.2.1 ATTRIBUTE VARIABLES:

Attribute variables are those characteristics that cannot be altered by the experimenter. Sex, socio-economic status, intelligence and ability of the students, School atmosphere, facilities of instruction, equipments used in instruction, instructional materials, time and period of exposure to a particular condition, reward and punishment during instruction, evaluation procedure, were the attribute variables. Such variables have been determined, but the experimenter can decided to include them or remove them as variables to be studied.

Characteristics- It is a special type of independent variable as secondary independent variable selected for the study to determine the effects of relationship between the primary independent variable and dependent variables.
a) Intelligence, Ability of Learning – As the groups were equally matched, this factor was taken care of.

b) Age – All the students were of nearly same age group.

c) Sex – It was decided not to include this variable in the study.

d) Socio-Economic Status, Classroom Situation – All the students from both schools were in same Satara city. So there was no physical difference, the entire subject got the same physical condition. It was decided to teach all the topics or content in the same month. It helped in controlling time of instruction variable.

3.4.3 CONFOUNDING VARIABLES:

Confounding variables were those aspects of the study that might influence the dependent variable and whose effect may be confused with the effects of the independent variable. Confounding variables were of two types: Intervening and Extraneous variables.

3.4.3.1 INTERVENING VARIABLES:

The intervening variables as anxiety, fatigue, and motivation have been determined. They must be controlled through the use of equivalent group design.

3.4.3.2 EXTRANEOUS VARIABLES:

Extraneous variables were those uncontrolled variables that may have a significant influence on result of a study. Many research conclusions were questionable because of the influence of these extraneous variables. Randomization technique was used in controlling the extraneous variables. Two groups of the students selected from grantable schools in Satara city which helped the researcher in controlling socio-economic status, age, classroom situation, intelligence, reward and punishment effects, abilities of learning.

It was decided to teach all the contents in the same one month. This helped in controlling time of instruction variable.

(J. W. Best: 2011 pp 168,169)
Though there were so many independent variables, the researcher had decided to consider only two independent variables in his experiment viz. teaching with Mathematics Experiment Notebook and conventional method.

Following are the dependent and independent variables.

<table>
<thead>
<tr>
<th>Group</th>
<th>Independent Variables</th>
<th>Dependent Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>Teaching with Mathematics Experiment Notebook</td>
<td>Achievement of scores in terms of scores in pre over post-test</td>
</tr>
<tr>
<td>Control</td>
<td>Teaching with conventional method</td>
<td>Achievement of scores in terms of scores in pre over post-test</td>
</tr>
</tbody>
</table>

**Fig.: 3.4**
Dependent and Independent Variables

The effects of remaining independent variables on dependent variables were controlled.

**Treatment:**

The different conditions under which experimental and control group were put usually referred to as “treatment”.

### 3.5 RESEARCH TOOLS:

The researcher observed and measured functional competencies. The researcher used the following tools in data collection for the present study:

- Mathematics Experiment Notebook (MEN) (Appendices T₁, T₂, T₃)
- Questionnaires (Appendix C and I)
- An Opinionnaire (Appendix H)
- Interview (Appendix J)
- Achievement Tests (Pre and Post) (Appendices F₁, F₂ and F₃)

#### 3.5.1 MATHEMATICS EXPERIMENT NOTEBOOK (MEN)

The researcher prepared the Mathematics Experiment Notebooks as an instructional material to teach Mathematics to upper primary classes on the basis of Instructional system design (ISD); the CBSE published the document ‘Guidelines for Mathematics Laboratory in Schools’ and the discussion with experienced school teachers.
3.5.1.1 PROCEDURE FOR DEVELOPING INSTRUCTIONAL MATERIAL

Any instructional system should be designed properly. Instructional design refers to the systematic process of translating principles of learning and instruction into plans or specifications for instructional materials or activities.

3.5.1.2 INSTRUCTIONAL SYSTEM DESIGN

The concept of Instructional system is one of the main outcomes of the applications of system approach in Education. It helps in optimizing human learning.

In traditional teaching learning process, there are some barriers to optimal learning.

These barriers can be minimized by using following principles.

1. Every learner should get a chance to participate in the process of learning.
2. All learners should participate in the process of learning actively.
3. The learners should receive positive and negative reinforcements on their responses and appropriate feedbacks whenever needed.
4. The learner should be able to construct their own questions. Clues should be provided to them to solve the questions.
5. The newly learned material may be forgotten by the learners, hence for long time retention, the material or skill should be repeated for a number of times in controlled condition.
6. The learner should be provided with a material having varied learning experience; this will motivate them for self learning.
7. Many tasks in the process of learning a skill are of complex or high level. There tasks should be divided into small discrete steps using maxim of simple to complex.
8. The learner should be provided information about their progress during the process of learning complex tasks.
9. The learner should be allowed to proceed with their own speed but with full understanding of subtasks.
10. The learner should develop the ability to organize their own learning experiences, provided clues for their own behavior and reinforce themselves for correct responding, learner can became self teachers.

In short, for efficient and optimal learning, the learner should proceed through learning process, at their own speed, own desire, with self questioning and feedback, using small steps of task.

Such type of learning is possible only when specially developed Instructional System Design (ISD) Model.

3.5.1.3 INSTRUCTIONAL SYSTEM DESIGN MODEL

The ISD concept has been in use for at least 25 years. Conceivably, there are as many approaches to the process as there are practitioners of it. The basic model is simple to understand and easy to use in almost any training environment. Essentially, it is a series of steps leading to the production of a successful training programme.

The ISD steps for building a course are analogous to steps for building a home. Building a quality home requires a systematic process so the home meets standards---personal, structural, and community standards among them. It could be disastrous if one left out a critical step, such as drawing up the blueprints.

The same ideas apply to developing quality training. Most ISD approaches contain five major phases (see Figure 3.1). The first four phases (analysis, design, development and implementation) are generally sequential; the outputs of one phase are the inputs to the next. The fifth phase, evaluation, involves feedback that applies throughout the model. This lesson looks at these phases and describes their purpose, relationships, and results.

---

**Fig. 3.5**

The phases of the Instructional System Design (ISD) model
I. ANALYSIS

Analysis involves research, and the skills required to conduct a good instructional analysis are similar to those of any good investigation: thoroughness, objectivity, and a systematic approach. This phase determines training needs and expresses them as information useful for training development. The ISD model requires that training should fulfill specific needs. This is done through the generation and evaluation of such analysis elements as needs assessment, job analysis, and target audience analysis.

A. Needs assessment

A needs assessment is conducted when a job performance problem has been identified. Needs assessment involves a systematic identification of solutions to performance problems. The assessment determines the root cause of the problem, then proposes a solution. The problem may be due to inadequate training, poor job documentation, poor equipment, lack of motivation, or other organizational issues. Conducting training without repairing faulty equipment, for example, will not solve the problem; it will only exhaust resources. Needs assessment determines whether training, alone, will solve the problem.

B. Job analysis

Job analysis is a systematic method of listing all the tasks necessary to competently do a specific job. These tasks represent the foundation on which we construct performance-based training objectives, course content, and evaluation instruments. Simply putting, the job analysis provides a detailed "picture" of the job to be trained. The job analysis can also provide information about entry-level skills and possible prerequisites for training.

C. Target audience analysis

A target audience analysis identifies characteristics that affect trainee learning. The analysis includes information about trainees' educational background, previous training experiences, relevant work experiences, and motivation for training. This information helps designers customize training for the intended audience.
The analysis phase also identifies training requirements and training outcomes. Training requirements are the knowledge and skills that must be taught during training. Training outcomes are the tasks that trainees must demonstrate to ensure competent performance back on the job.

II. DESIGN

The design phase is the planning stage of ISD. Its purpose is to transform relevant content into concise, behavioral objectives, creating the instructional "blueprint" that will direct the development of all training materials, tests, and methods. Training requirements and outcomes identified during analysis are written as goals and objectives. Then other design elements are addressed, such as instructional strategies, media selection, types of training materials, evaluation methods, and the design document.

A. Goal statements

A goal statement is a broad general description of the learning outcome. It describes what the trainee will be able to do at the end of the training. Goal statements are written for the entire course, as well as for each lesson within it.

B. Instructional objectives

An instructional objective specifies a measurable level of a behavior for a trainee after training, including the conditions and standards for the performance. Objectives are used to ensure achievement of the larger goal. Viewed as a unit, lesson objectives are the detailed steps leading to attainment of the lesson goal. Usually, several instructional objectives are written for each lesson goal.

C. Instructional strategies

Since objectives form the framework for the training structure, the sequence of objectives is a very important part of lesson design. Objectives may be arranged in the order that tasks will be performed on the job, by their ease of performance, by order of the complexity of the task, or according to other appropriate strategies.

D. Evaluation methods

Decisions on how trainees will be evaluated or tested are made in the design phase. Evaluation options include knowledge tests and performance tests. If a trainee learns by practicing a skill during training, the trainee must perform it when
evaluated. He or she should not be evaluated with multiple-choice questions or by describing the skill in writing.

E. Types of training materials

Training materials include such items as texts, student guides, workbooks, instructor guides, job and training aids, visual aids, and case studies. While these items are produced in the development phase, they are identified in the design phase.

F. Media selection

Taking target audience characteristics, number of trainees, and environmental requirements into account, decisions are made about how to deliver the training to meet instructional objectives. One of these decisions is media selection, the course designers' choice of appropriate instructional media for a course. Media selection requires a close look at the strengths and weaknesses of each medium based on the type of student, what he or she needs to learn, and how to teach it.

Growth in electronic technology has substantially increased the media options for delivery of training. Today's media choices include video, computer-based training, interactive television, video-conferencing, written correspondence, and online training, along with the usual classroom or workshop options. Choices may change from goal to goal and lesson to lesson to get the best training results from the available media. Many electronic media now provide delivery of training or partial training without trainees ever entering a traditional classroom--we call this distance learning.

G. Design Document

The outcome of the design phase is an instructional "blueprint," a design document that guides development, delivery, and evaluation of the training. Often a design document details design decisions that guide the training development team in production of course materials. In addition, the design document serves as a managerial review instrument in the approval process required at this stage of training development.

III. DEVELOPMENT

The development phase translates design decisions into training materials. This is where the real work of course development is done. Using the objectives,
instructional approach, and media selections from the design phase, development produces course materials for the trainer, course materials for the trainee, and evaluation instruments.

A. Course materials for the trainer

Lesson plans are the major element constructed during this phase. They function as a written "advance organizer" for the delivery of lessons by the instructor. Course materials include anything the instructor will need to present the lesson, including workbooks, handouts, visual aids, demonstration, media equipment, and administrative materials.

B. Course materials for the trainee

Course materials for the trainee are materials that support and supplement lessons. These may include handouts that provide a summary of the presentation, replace or facilitate note taking, and provide references or job assistance back in the workplace.

C. Evaluation instruments

Testing and evaluating trainees' skills is a familiar part of learning and ISD. Often trainees are evaluated with cognitive or performance-based tests. Any form selected must test the trainees' mastery of lesson objectives. Written tests may include multiple-choice questions, and performance checklists may be used to record behavioral skills. The evaluation approach, form, and content identified in the design phase are produced in the development phase.

The development phase produces a standardized, documented approach to training delivery. This outcome assures that a trained, qualified instructor can deliver this training confident that training goals and objectives will be met.

IV. IMPLEMENTATION

The implementation phase focuses on the details of training delivery. Logistical arrangements, such as scheduling a training place, preparing an agenda, setting up the training environment, and even practicing the presentation ensure delivery of a training session that captures trainee interest.
A. Logistical arrangements

Logistical arrangements are addressed in the implementation phase. These are time-sensitive planning and coordinating details such as scheduling training facilities, arranging for the set-up and use of equipment, accommodating guest speakers, etc. Another step is generating the training schedule. This schedule ensures that the trainer and trainees are informed of all events programme med to occur during training.

A good training environment is critical to good learning outcomes. Arranged well in advance, the training environment should fully support delivery of training. In a classroom or other on-site setting, comfortable yet functional furniture, work areas, equipment, safety plans, and training materials should be ready to meet the learning needs of each trainee, including those with special needs. When using a distance-learning medium, distant-site facilitators should prepare training environments at their sites. In the case of on-line training, site facilitators or training department staff must schedule trainees' access to computer terminals and server connections.

Training room heating and cooling, lighting, and trainee accesses to rest rooms, food facilities, smoking areas, telephones, and parking are additional considerations that require preplanning. Most administrative tasks should be completed well in advance of training: trainee registration, issuance of maps and directions, etc. Another aspect of preparing the training environment is arranging for facilitation of a social climate conducive to group formation and peer interaction. Placement of furniture, rules of conduct, and "ice breaker" activities are useful for creating a desirable social climate.

B. Delivery of training

Delivery of the training is next in the implementation phase. The trainer must employ adult learning principles throughout the presentation. Using effective verbal and nonverbal techniques, the trainer must engage the trainees and demonstrate the appropriate skills necessary to achieve instructional objectives. He or she then must permit the trainees to practice their new skills, evaluate trainees' learning, and provide the trainees with feedback and an opportunity for remediation. The desired outcome of implementation is a roster of educated, skilled trainees.
V. EVALUATION

The purpose of evaluation is to ensure that training-under-development stays on track, safeguarding achievement of training goals. Decisions about revisions for future course iterations can be made after evaluating the strengths and weaknesses in a completed training programme. Finally, evaluation ensures that training improves performance back on the job. The ISD process includes two types of evaluation: formative and summative.

A. Formative evaluation

Formative evaluation monitors the training as it proceeds through the ISD process. Monitoring involves periodically reviewing the analysis and design documents to confirm that objectives are being developed and delivered as originally intended.

B. Summative evaluation

Summative evaluation is the process of reviewing a course or training after it is taught. It includes measurement of training outcomes in terms of trainees' opinions about the training, test results, on the job performance, and the benefit, or return on investment, of the training to the trainees' organization.

C. The feedback loop

Dynamic feedback loops are very important parts of the ISD evaluation process. If the training under development does not satisfactorily proceed through a particular ISD phase, checking it against specifications from an earlier phase may identify the problem. If a problem is identified, the training product must be corrected in the deficiency phase. For example, if the implementation phase training does not teach actual job skills performed at the trainees' job sites, the initial job analysis may be in need of revision. Back in the analysis phase, the training package must be corrected and re-developed from that point forward.

Training developed with the ISD model depends upon systematic movement through all five phases at least once or more than once, if revision is necessary. The evaluation phase tells us if training was successful, how successful it was, and where to correct the problems. Evaluation is the ISD phase that ties all other phases together.
through feedback. The outcome of one phase becomes input for the next. Feedback ensures that the transition of training through the phases stays on course.

SUMMARY

Analysis, design, development, implementation, and evaluation: these are the production steps of training. They are also the phases of the systematic process for the development of training known as ISD. The strengths of the ISD approach are its simplicity, reliability, self-adjusting mechanism, and applicability to a broad range of training and educational needs. Withstanding the test of time, ISD persists as a strong influence in contemporary training.

(http://en.wikipedia.org/wiki/instructional_design)

(http://www.Instructionaldesigncentral.com/htm/IDC_instructionaldesigndefinitions.htm)

3.5.1.4 DEVELOPED MATERIALS:

An instructional package usually consists of student manual, instructional materials, pre- and post-tests, and an instructor's manual. You may choose to employ worksheets, handouts, job aids, computer-based training, the Internet, laboratory work, learning objects, learning portals, or audio/video material.

Prior to developing your instructional materials, consider your intended development and delivery mode. Will your delivery mode be self-paced and instructor-independent, such as online learning? Will your delivery be a combination of instructor presentation and use of materials? Think about how you will cover all required instructional events. Consider, too, the resources and budget you have available.

Also, consider whether you wish to create your own instructional materials or whether you want to use materials that already exist. Remember, though, to avoid using material just because it's available; make sure the material is appropriate for your instructional goals.
When developing your instructional material, think about using the following steps:

1. Review your instructional strategy.
2. Research existing literature or fellow subject matter experts; determine what material is available.
3. Consider how you can adapt existing material.
4. Determine whether you need to design new materials.
5. Consider the best media for presentation. How can you best monitor practice and feedback, evaluate learner learning, and guide student learning?
6. Based on your instructional strategy, build your instructional material.
8. Develop a student manual or student instructions; provide a syllabus or outline that informs learners of objectives and assignments.

3.5.1.5 PRINCIPLES TO BE CONSIDERED WHILE DEVELOPING WRITTEN INSTRUCTIONAL MATERIAL

1. Readiness
2. Goal Guidance
3. Text Comprehension
4. Low Information Density
5. Simple Language
6. Examples and illustrations
7. In text questions or activities
8. Small steps
9. Writing style
10. Reconciliation
11. Visualisation
12. Makeup of the text
13. Gap principle
14. The irrelevancy principle
15. Mastery principle

The stimulus material for the instructional system can be obtained from two sources

a. External source such as text-books, curriculum guides etc. commercially produced material.

b. Material prepared by teachers.

Teachers seldom get involved in the production of commercially materials but many times the material available is required to be modified to promote the learning outcomes more adequately.

3.5.1.6 BASIC ELEMENTS OF INSTRUCTIONAL DESIGN

1. Determining the needs of the learners and examining the learning context and environment
2. Determining the outcomes of the learning programme or course and formulating the learning objectives
3. Developing appropriate and meaningful assessment criteria and procedures
4. Establishing the most effective approach(es) to delivering the instruction
5. Testing and evaluating the effectiveness of the instructional system (both the instruction itself and the performance of the learner)
6. Implementing, adjusting and maintaining the instructional system.

3.5.1.7 STEPS INVOLVED IN THE PREPARATION OF INSTRUCTIONAL MATERIAL

Many instructional technologists have given various steps and phases, sub steps; these are summarized in the figure shown.
|---|---|---|---|---|---|---|---|---|

Fig.3.6

Steps involved in the preparation of instructional material
The observation of figure reveals that

1. The number of steps given by different technologists varies from five to ten.

2. The names of the steps also different, however a few terms are common.

3. Some technologists have specified main steps and sub-steps while other instructional technologists have not mentioned sub-steps.

4. Some sub-steps given by a few technologists have been designated as main steps by others.

It is also evident that although there is a variation in the steps suggested by these instructional technologists, these are many common steps. These are listed below.

1. Task analysis based on job information.

2. Collection of research and information.

3. Planning

4. Development of prototype

5. Tryout and revision

6. Final product development

7. Installation and field testing product

8. Final product revision

9. Dissemination in the field

10. These common steps and activities involved there in are discussed bellow.

The researcher considered all these steps and principles of ISD stated earlier for the preparation of the first draft of the Mathematics Experiment Notebooks for upper primary classes. The details of them are as follows.

3.5.1.8 OBJECTIVES OF MATHEMATICS EXPERIMENT NOTEBOOK

The objectives of prepared Mathematics Experiment Notebook were as follows.

1. To provide an opportunity to the students to understand and internalize the basic Mathematical concepts through concrete objects and situations.
2. To enable them to verify several geometrical properties and facts using models or by paper cutting and folding techniques.

3. To provide an opportunity to students to apply Mathematical facts and principles in an actual life.

4. To help the students in developing the habit of verification and own learning.

5. To enable them to learn by doing and Learning by observation and things so learnt are retained in the mind for a longer time.

6. To develop an interest and confidence in learning the Mathematics.

7. To enable the teacher to demonstrate, explain and reinforce abstract mathematical ideas by using concrete objects, models, charts, graphs, pictures, posters, etc.

The aim behind the above objectives was to achieve teaching strategy and steps involved in developing the Mathematics Experiment Notebooks in the following way.

3.5.1.9 STEPS FOR PREPARING THE MATHEMATICS EXPERIMENT NOTEBOOK:

The national aspirations and expectations are reflected in the recommendations of the National Curriculum Framework-2005 developed by NCERT. Further NCERT, Delhi has published a document ‘A Handbook for designing Mathematics Laboratory in schools’ according to the recommendations of National Curriculum Framework-2005. The Central Board of Secondary Education (CBSE) has issued notification to introduce the concept of Mathematics Laboratory in Schools. (Circular No.: 03/04 dated 28th Jan. 2004.) Further the CBSE issued the circular to introduce of Mathematics Laboratory and gave guidelines about Internal Assessment. (Circular No.: 14 dated 29th June 2006.) The CBSE also published the document ‘Guidelines for Mathematics Laboratory in Schools’.

Taking those guidelines into consideration, the researcher thought to make teaching and learning of Mathematics at school stage activity-based and experimentation oriented. He thought that the concept of Mathematics Experiment Notebook would help in enhancing teaching-learning process.
Step I: Identification of topics and contents:

To test Specific Objective No. 1 (i.e. to analyse the textbook of upper primary classes in order to locate areas suitable for developing Mathematics Experiment Notebooks) the researcher discussed with school teachers frequently on the experiments of Mathematics who were teaching to upper primary classes. For the preparation of Mathematics Experiment Notebooks, some units in the syllabus were needed to be selected. The objectives of the discussion were:

1. To find out difficulties faced by the subject teachers in teaching Mathematics.
2. To know the practices used in different schools for teaching Mathematics.
3. To know the views of the teachers about teaching Mathematics experimentally.
4. To identify the topics and content for the preparation of experiments.

Taking into consideration, the opinions of the school teachers from different schools, the topics for the Mathematics Experiment Notebook were finalized.

3.5.1.10 INVESTIGATORS THINKING:

Taking into consideration the teachers responses regarding selection of units that could be taught through experiment, the researcher thought over these units and selected those units for the experiment that matched the teacher responses.

In the selected units, the investigator was sure that the student would get the opportunity to acquaint themselves with the facts through direct experience individually and verify the facts, such as weight, measurement, speed, time, distance, work average, area, volume, laws, formulae, construction, geometrical properties etc. The selected topics from upper primary classes were listed in Appendix D.

Step II: Preparation of Mathematics Experiment Notebook:

After selecting units contents were analysed and organised in programmed manner. All the experiments were arranged on the basis of psychological principles of learning i.e. proceeding from easy to difficult, simple to complex and from known to unknown.
Broadly, the following steps were considered for every experiment.

1. Title of the experiment
2. Objective of the experiment
3. Description/Analysis of the experiment, with figure
4. The procedure of the experiment- How the experiment is to be conducted.
5. The prediction obtained after doing the experiment several times.
6. The prediction may be a correct result or may not be correct.
7. Mathematical proof/disproof of the above prediction.
8. The result (Theorems/Generalisations)
9. The open-ended questions relating to this experiment.

**Step III: Checking the Content Validity:**

Prepared Mathematics Experiment Notebook was given to the experienced school teachers (Appendix L) for checking content validity. According to following analysis of the opinionnaire (Appendix H) and suggestions the appropriate changes were made.

**3.5.1.11 EXPERIENCED SCHOOL TEACHERS’ OPINION ABOUT THE MATHEMATICS EXPERIMENT NOTEBOOK (MEN)**

To test **General Objective No. 1 of the study** (to develop a Mathematics Experiment Notebook to teach Mathematics to Upper Primary classes.) the investigator collected the information from all stakeholders and beneficiaries.

The internal evaluation of the MEN about content was done by the experienced school teachers.

For that Likert type opinionnaire (Appendix H) was given to them. The Likert opinionnaire with five point scale was used for the internal validity. The responses were strongly agree, Agree, Undecided, Disagree, Strongly disagree. In that opinionnaire, the statements 1,3,4,8 and 10 were favourable while the remaining statements 2,5,6,7 and 9 were unfavourable.
The value weightage was shown in Table 3.1 for responses to favourable and unfavourable statements. The response given by the respondents is shown in following tables.

**TABLE 3.2**

RATING IN LIKERT TECHNIQUE

<table>
<thead>
<tr>
<th>Five Points</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Favourable</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Unfavourable</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

The Mathematics Experiment Notebooks were sent to 25 Experienced School Teachers. The conclusions were drawn based on the opinions of accepted statements by the content experts about the Mathematics Experiment Notebooks. The analysis is given in tables 3.2 and 3.3 below.

**TABLE 3.3**

ANALYSIS OF FAVOURABLE STATEMENTS IN OPINIONNAIRE

<table>
<thead>
<tr>
<th>Favourable Statements</th>
<th>No of respondents according to rating score</th>
<th>Summated Score</th>
<th>Weightage * Respondents</th>
<th>% Score Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25 - - - -</td>
<td>125</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>20 3 2 - -</td>
<td>118</td>
<td>94.40</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>22 1 2 - -</td>
<td>120</td>
<td>96.00</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>20 2 3 - -</td>
<td>117</td>
<td>93.60</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>23 1 1 - -</td>
<td>122</td>
<td>97.60</td>
<td></td>
</tr>
</tbody>
</table>
Observations and Interpretation:

The above table shows that-

All the favourable statements were agreed by the respondents as the percentage of each statement was more than 90. It indicates that all the respondents strongly agreed the positive statements about the Mathematics Experiment Notebooks. Therefore, the researcher accepted all the statements discussed above.

**TABLE 3.4**

**ANALYSIS OF UNFAVOURABLE STATEMENTS IN OPINIONNAIRE**

<table>
<thead>
<tr>
<th>Unfavourable Statements</th>
<th>No of respondents according to rating score</th>
<th>Summated Score</th>
<th>Weightage * Respondents</th>
<th>% Score Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>3 22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-</td>
<td>2 23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1 24</td>
<td>124</td>
<td>97.60</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1 24</td>
<td>124</td>
<td>97.60</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1 24</td>
<td>124</td>
<td>97.60</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>1 24</td>
<td>124</td>
<td>99.20</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1 24</td>
<td>124</td>
<td>99.20</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1 24</td>
<td>124</td>
<td>99.20</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>1 24</td>
<td>124</td>
<td>99.20</td>
<td></td>
</tr>
</tbody>
</table>

Observations and Interpretation:

The above table shows that-

The responses about the unfavorable statements were more than 90 %. It indicates that all the respondents strongly disagreed the unfavourable statements about the Mathematics Experiment Notebooks. Therefore the researcher rejected all the statements discussed above and accepted them positively.

The statements accepted by the researcher about the Mathematics Experiment Notebooks are as follow:

1. All the expected subunits are included in the Mathematics Experiment Notebooks.
2. The content in the Mathematics Experiment Notebooks is errorless.
3. The content presented in the Mathematics Experiment Notebooks is effective.
4. The Mathematics Experiment Notebooks is user friendly.

5. Open ended questions given for the practice, clarify the concepts and enhance the interest about Mathematics.

**Step IV: Checking the Methodology and Validity:**

Prepared Mathematics Experiment Notebooks and curriculum clarity format were given to the research expert for checking methodology and validity. Curriculum clarity format is a useful tool to evaluate any course/ programme. It gives clear-cut idea about all aspects that are needed to have in any programme to be prepared for teaching upper primary students. The booklet ‘Curriculum Clarity Format’ published by the Yashwantrao Chavan Maharashtra Open University, Nashik (1996) referred by the researcher. With the help of the format given in this booklet, he prepared the Curriculum Clarity Format (Appendix J) to be used to evaluate the Mathematics Experiment Notebooks he had prepared. (Appendices T1, T2 and T3) He then gave Curriculum Clarity Format to five research experts along with the copy of the Mathematics Experiment Notebooks and got it filled. The evaluation made by them proved that the prototype was appropriate and indicated to implement the Mathematics Experiment Notebooks for the teaching upper primary classes.

According to following analysis of the questionnaire (Appendix I) and Curriculum Clarity Format (Appendix J) and suggestions the appropriate changes were made.

**3.5.1.12 RESEARCH EXPERTS OPINION ABOUT THE MEN**

The internal evaluation of the MEN about the methodology was done by the research experts. Opinions of research expert about the Mathematics Experiment Notebook (Appendix K) are given in the following table. The three point scale was prepared for the response of the research experts. The options were Yes, To some extent and No. The analysis of research expert’s questionnaire is shown in Table 3.4.
TABLE 3.5
ANALYSIS OF RESEARCH EXPERTS RESPONSES REGARDING THE MEN

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Aspect of Analysis of Mathematics Experiment Notebook</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>1</td>
<td>Instructions are clearly stated</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>All activities are mentioned</td>
<td>80</td>
</tr>
<tr>
<td>3</td>
<td>Figures, Graphs are clearly plotted</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>Use without the help of teacher</td>
<td>60</td>
</tr>
<tr>
<td>5</td>
<td>Content is related to objective</td>
<td>80</td>
</tr>
<tr>
<td>6</td>
<td>Experiment Procedure is clearly mentioned</td>
<td>80</td>
</tr>
<tr>
<td>7</td>
<td>Flexible in different learning situation</td>
<td>80</td>
</tr>
<tr>
<td>8</td>
<td>Clarify the concepts by the Experiments</td>
<td>80</td>
</tr>
<tr>
<td>9</td>
<td>Open-Ended questions are proper</td>
<td>80</td>
</tr>
<tr>
<td>10</td>
<td>Easy &amp; Happy learning</td>
<td>80</td>
</tr>
</tbody>
</table>

Observation and interpretation:

The above table shows that-

1. Majority of the research expert (60 %) thought that instructions were clearly stated in MEN.

2. The figure, graph and activities were clearly plotted; according to 60 to 80 % experts.

3. Majority of the research expert (60 %) were of the opinion that the MEN was useful to students without teachers.

4. Ninety percent of experts opined that the content of MEN was related to objective and Open-Ended questions were proper.

5. Eighty percent of the research experts were of the opinion that the Experiment Procedure was clearly mentioned.

6. Experts who thought that MEN were flexible in different learning situation were in majority (80 %).

7. Majority of the experts (80 %) were of the opinion that MEN clarify the concepts and a good tool of happy learning.
**Step V: Appropriate Changes:**

The researcher prepared questionnaire for experienced Mathematics teachers who were teaching to upper primary level and also for research experts. He also prepared opinionnaire for the experienced school teachers. The teachers and experts were gave the valuable suggestions for the improvement of MEN.

The analysis was done on the following basis.

1. Analysis of questionnaire of experienced Mathematics school teachers for present position of teaching Mathematics. (Appendix C)

2. Analysis of opinionnaire about Mathematics Experiment Notebook by experienced school teachers. (Appendix H)


4. Analysis of questionnaire about Mathematics Experiment Notebook by research experts. (Appendix I)

5. Analysis of Curriculum Clarity Format about checking the MEN by research experts. (Appendix J)

6. Suggestions given by research experts.

The appropriate changes were made in the Mathematics Experiment Notebook according to the instructions given by the content and research experts.

**Step VI: Consent of the authorities:**

Prior to the conduct of the experiment the permission of the authorities (Appendices A₁ and A₂) was sought for.

1. The Principal, Azad Collage of Education, Satara. The entire plan of the experiment was discussed with the Principal. He heartily gave his consent.

2. The Headmasters of the schools, For the real classroom teaching, the headmasters of the schools, namely (1) Annasaheb Kalyani Vidyalaya, Satara, and (2) Maharaja Sayajirao Vidyalaya, Satara (Appendices A₁ and A₂) were requested to make available the students for the experiment. They gladly accepted the request and promised to extend their co-operation whenever required. (Appendix N).
3. The Mathematics subject teachers of both the schools (Appendix W), who were teaching to those classes, were requested to take active participation for the experiment. They gladly accepted the request and promised to extend their cooperation whenever needed.

**Step IX: Organizing Achievement Tests:**

The achievement tests (Appendices F₁, F₂ and F₃) were constructed and administered on two equivalent groups of students. The same achievement test was used as pre and post-test in experiment.

The main objective of the pre-test was to examine the achievement level of the students before the treatment. The main objective of the post-test was to examine the achievement level of the students after the treatment.

The researcher used this achievement test tool to find out the achievement of the students in both the groups involved in the study.

**Step VII: Pilot Study:**

To verify the reliability of the MEN the researcher conducted a pilot study in Annasaheb Kalyani Vidyalaya, Satara to ascertain the strengths and weaknesses of developed Mathematics Experiment Notebook (MEN). The copies of the MEN were made available to a group of potential users called a try-out sample (TOS) (Appendix O), to get valuable feedback about the application.

The researcher wanted to check the reliability of the developed MEN. It was very important to do pilot testing before implementation of the prototype in large scale. This was done in following manner.

1. Marks achieved by the students in the last term examination in Mathematics were collected.
2. Two equivalent groups were made on the basis of these marks.
3. Group of 60 students of class VII was selected for this TOS. (Appendix O)
4. One group was controlled and another was treated as an experimental group.
5. Pre-test was given to both groups and results were drawn.
6. Prepared MEN was given to experimental group.
7. Traditional method was applied for teaching on control group.

8. Post-test was given to both groups and results were drawn.

9. Students’ interviews regarding the MEN were conducted and changes were made according their suggestions.

3.5.1.13 PILOT STUDY:

It is very important to do pilot testing before implementation of the prototype in large scale. So researcher used the following experimental design.

The researcher used the Pretest-Posttest Equivalent - Groups design in small-scale try out sample (TOS). The design is explained below:

\[ R_1 \rightarrow O_1 \rightarrow X \rightarrow O_2 \]
\[ R_2 \rightarrow O_3 \rightarrow C \rightarrow O_4 \]

Where \( O_1, O_3 \) = pre-test, \( O_2, O_4 \) = post-test \( X = \) Treatment (Mathematics Experiment Notebook), \( C = \) Conventional Instructional System.

<table>
<thead>
<tr>
<th>Pretest-Posttest Equivalent - Groups design</th>
<th>( O_1, O_3 ) - Exp.</th>
<th>( O_2, O_4 ) - Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Treatment</td>
<td>Conventional</td>
</tr>
<tr>
<td>2</td>
<td>PRE-TEST</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>POST-TEST</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 3.7

Pretest-Posttest Equivalent - Groups design

3.5.1.14 SAMPLING USED IN PILOT STUDY:

Focus group testing was pilot testing of the system. The Pretest-Post-test Experimental design was used the pilot study. The experimental and control group consists of 30 students. (Appendix O)
The groups were evaluated by administrating pre and post-test specially prepared achievement test for the purpose. The application was revised accordingly.

The data obtained was classified, analyzed and interpreted.

3.5.1.15 THE EXPERIMENT USED IN PILOT STUDY:

The experiment was conducted within one month, the procedure of which is explained in the following paragraphs.

The researcher selected one school and 60 students from VII standard of Annasaheb Kalyani Vidylaya, Stara were the sample of the study.

The researcher administered a pre-test of 50 marks on the students (30) from both the groups then he gave a treatment of developed Mathematics Experiment Notebook to the experimental group at the same time the control group was treated with traditional system. He then administered a post-test of 50 marks on both the groups and compared the results. The data were analyzed and interpreted and the effectiveness of the system was tested.

3.5.1.16 ANALYSIS AND INTERPRETATION OF THE DATA OBTAINED IN PILOT STUDY:

The marks obtained by the students in pre-test and post-test were as shown in Appendix P₁ and P₂. The analysis and interpretation of the data obtained in pilot testing was explained as under.

3.5.1.17 ANALYSIS AND INTERPRETATION OF THE PRE-TEST DATA OF A TRY-OUT SAMPLE (TOS):

A pre-test was administered on the try-out sample to collect the information of the students about the performance of the students in Mathematics at upper primary level. The scores obtained by the students were given in the Appendix Q₁. Means and S.D. of the pretest scores were calculated.
**TABLE 3.6**

SIGNIFICANCE OF DIFFERENCE BETWEEN THE MEANS AND S.D.S FROM BOTH THE GROUPS FROM TOS IN PRE-TEST SCORES

<table>
<thead>
<tr>
<th>Measure</th>
<th>Control group</th>
<th>Experimental group</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>M</td>
<td>11.1</td>
<td>11.23</td>
</tr>
<tr>
<td>σ</td>
<td>2.29</td>
<td>2.89</td>
</tr>
<tr>
<td>D. means</td>
<td>0.13</td>
<td></td>
</tr>
<tr>
<td>D. S.D.s</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>t</td>
<td>0.19 (NS)</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>58</td>
<td></td>
</tr>
</tbody>
</table>

NS: Non Significant at 0.05 and 0.01 levels.

Required t-value for the df = 58 is 2.66 at 0.01 level
And 2.00 at 0.05 level

**Observations and Interpretations:**

1. Mean of control group is 11.1
2. Mean of experimental group is 11.23
3. Average mean of both the groups is 11.17
4. The mean difference is 0.13. There is little difference in the means of both the groups.
5. The S.D.’s are 2.29 and 2.89 respectively for control and experimental groups. The difference between two SD’s is 0.70, there is no much difference in the SDs of the groups from the mean.
6. The calculated t-value is 0.19.

**Findings:**

From the above observations and interpretations it was found that,

The differences between the means of students from control and experimental groups in pretest scores was 0.13 and this found to be non-significant at 0.05 and 0.01 levels of significance because the t value is less than the required value for df 58. It means that students from any group do not differ in their performance in the pretest.
From the above table 3.1 it can be confidently interpreted that both the groups were equivalent in their achievements before going to a further treatment.

3.5.1.18 ANALYSIS AND INTERPRETATION OF THE POST-TEST DATA OF A TRY-OUT SAMPLE (TOS).

The analysis and interpretation of the data obtained in pre-testing confirmed the equivalency of control and experimental groups. The control group from TOS was then exposed to conventional instructional system for the units decided and the experimental group from TOS was treated with the developed MEN for the same units. A post-test was again administrated on both the groups after the treatment. The data obtained in terms of scores was further analyzed and interpreted in the following tables. The original scores are given in Appendix P₁ and P₂.

**TABLE 3.7**

SIGNIFICANCE OF DIFFERENCE BETWEEN THE MEANS AND S.D.S FROM BOTH THE GROUPS FROM TOS IN POST-TEST SCORES

<table>
<thead>
<tr>
<th>Measure</th>
<th>Control group</th>
<th>Experimental group</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>M</td>
<td>21.37</td>
<td>30.17</td>
</tr>
<tr>
<td>σ</td>
<td>2.87</td>
<td>4.36</td>
</tr>
<tr>
<td>D. Means</td>
<td>8.8</td>
<td></td>
</tr>
<tr>
<td>D. S.D.s</td>
<td>1.49</td>
<td></td>
</tr>
<tr>
<td>t</td>
<td>9.23 (S)</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>58</td>
<td></td>
</tr>
</tbody>
</table>

S: Significant at 0.05 and 0.01 levels.

Required t-value for the df = 58 is 2.66 at 0.01 level

And 2.00 at 0.05 level

**Observations and Interpretations:**

1. Mean of control group is 21.37
2. Mean of experimental group is 30.17
3. Average mean of both the groups is 25.77
4. The mean difference is 8.8. There is much difference in the means of both the groups.

5. The S.D.s are 2.87 and 4.36 respectively for control and experimental groups. The difference between two SDs is 1.49; there is much difference in the SDs of the groups from the mean.

6. The calculated t-value is 9.23.

Findings:

The difference between the means of students from control and experimental in post-test is found to be significant at 0.05 and 0.01 levels of significance because the t value is greater than 2.00 and 2.66 for df 58 which means that the students from experimental group differ in their performance as compared with the students from the control group in the posttest.

From the above table 3.2 it can be confidently interpreted that as the differences between the means were significant. It means that the treatments in the groups affected the variability for students.

The analysis and interpretation of the data obtained in post-testing indicate that the developed MEN helped the students from experimental group in performing better than the control group.

A comparative graph of the scores obtained by every individual from control and experimental group in pre and posttest is shown in the following way.

Fig. 3.8

Scores obtained by every individual from control and experimental group in pre and post-test.
The graph shown in Fig. 3.4, clearly explains that the scores obtained by the students from experimental group in posttest are superior to the students from control group.

### 3.5.1.19 ANALYSIS AND INTERPRETATION OF THE PRE OVER POST-TEST DATA

From the preceding tables, it was found that the control and experimental groups performed well in achievement tests. In order to understand ‘How much they could improve in the achievement in their respective groups?’ The data were further analyzed to compare the differences between their performances on pre over post-test t-test and F-test techniques were used.

#### TABLE 3.8

**SIGNIFICANCE OF DIFFERENCE BETWEEN THE MEANS AND SD’S FROM CONTROL AND EXPERIMENTAL GROUPS FROM TOS IN PRE OVER POST-TEST**

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pre-test</th>
<th>Post-test</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>σ</td>
<td>M</td>
<td>σ</td>
<td>D. Means</td>
<td>D.SD’s</td>
</tr>
<tr>
<td>CG</td>
<td>30</td>
<td>11.23</td>
<td>2.89</td>
<td>21.37</td>
<td>2.87</td>
<td>10.14</td>
<td>0.02</td>
</tr>
<tr>
<td>EG</td>
<td>30</td>
<td>11.1</td>
<td>2.29</td>
<td>30.17</td>
<td>4.36</td>
<td>19.07</td>
<td>2.07</td>
</tr>
</tbody>
</table>

S: Significant at 0.05 and 0.01 levels.

Required t-value for the df = 58 is 2.66 at 0.01 level

And 2.00 at 0.05 level

Required F-values for the df = 1-58 are 7.08 at 0.01 level

And 4.00 at 0.05 level

**Observations and Interpretations:**

1. Mean’s of control group are 11.23 and 21.37 respectively in pre-test and post-test.
2. Mean’s of experimental group are 11.1 and 30.17 respectively in pre-test and post-test.

3. The mean difference is 10.14. There is much difference in the means of pre-test and post-test.

4. The S.D.s of control group are 2.89 and 2.87 respectively in pre-test and post-test.

5. The S.D.s of experimental group are 2.29 and 4.36 respectively in pre-test and post-test.

6. The S.D.s difference is 2.07. There is much difference in the S.D.s of pre-test and post-test, there is much difference in the SDs of pre-test and post-test from the mean.

7. The calculated t-value are 13.64 and 21.21 respectively in control and experimental groups. It was found to be significant at 0.05 and 0.01 levels of significance because the calculated t -values are greater than 2.00 and 2.66 for df. 58.

8. The calculated F-value are 185.94 and 449.83 respectively in control and experimental groups. It was found to be significant at 0.05 and 0.01 levels of significance because the calculated F values are greater than 4.00 and 7.08 for df. 1-58.

Findings:

From the above table 3.3 it can be confidently interpreted that as the differences between the means and SD’s were significant.

It means that the students from the control group differ in their performance on pre over posttest scores. It means that the Conventional Instructional System used in the control group favored the students in achieving better performance.

It means that the students from the experimental group differ in their performance on pre over posttest scores. It means that the Developed Mathematics Experiment Notebooks used in experimental group favored the students in achieving better performance than control group.
3.5.1.20 CONCLUSIONS REGARDING PILOT STUDY OF THE PROTOTYPE:

The data received in try-out of the prototype were tabulated above (table 3.1 and 3.2). The analysis and interpretation of the data brought out following conclusions.

1. It was confirmed that the try-out sample was representative one.

2. As the overall impact of the prototype was found faithful, it was not found necessary to improve the entire prototype in total.

3. The try-out sample of the prototype also helped the researcher in formulating research and null hypothesis of the final experiment.

4. The content and research experts and students to improve the prototype also noticed the following suggestions.

5. Few corrections such as add questions, change the questions, figure and relating apparatus for the betterment of Mathematics Experiment Notebooks.

6. It was found that all items from the pre-test and post-test need no improvements; hence the items were kept as they were.

7. It was decided to test the sample through selected group of students to receive feedback and recommendations about the MEN.

The above improvements were done in the MEN before the experimentation.

The opinions through interview of the students about the MEN were collected in the following way.

3.5.1.21 STUDENT’S OPINIONS ABOUT THE MEN

The MEN was more important to students so their opinions about the Mathematics Experiment Notebook were also collected through interview. These students were not the part of the experiment. These are tabulated in the following table 3.5.
### TABLE 3.9

ANALYSIS OF STUDENTS’ INTERVIEW QUESTIONS

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Item</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Instructions are clearly stated</td>
<td>09(90) 01(10) 00(0)</td>
</tr>
<tr>
<td>2</td>
<td>Experiment procedure, Figures and Graphs are clearly plotted</td>
<td>09(90) 00(0) 01(10)</td>
</tr>
<tr>
<td>3</td>
<td>Content in MEN is errorless and effective</td>
<td>08(80) 01(10) 01(10)</td>
</tr>
<tr>
<td>4</td>
<td>MEN is user friendly</td>
<td>08(80) 00(0) 02(20)</td>
</tr>
<tr>
<td>5</td>
<td>Learning can easy with the help of MEN</td>
<td>08(80) 01(10) 01(10)</td>
</tr>
<tr>
<td>6</td>
<td>Clarify the concepts by the Experiments</td>
<td>06(60) 02(20) 02(20)</td>
</tr>
<tr>
<td>7</td>
<td>Open-Ended questions are proper</td>
<td>06(60) 03(30) 01(10)</td>
</tr>
</tbody>
</table>

(Numbers in the parenthesis indicate percentage.)

**Observation and interpretation:**

The above table shows that-

1. Ninety percent of the students were of the opinion that the instructions were clearly stated.

2. Greater part of the students (90%) opined that experiment procedure, figures and graphs were clearly plotted.

3. Majority of the students (80 %) thought that the content in MEN was errorless and effective; students agree with this statement.

4. Common of the students (80 %) were of the opinion that the MEN were user friendly.

5. Eighty percent students thought that the learning could be easy with the help of MEN.

6. Majority of the students (60 %) were of the opinion that the MEN clarify the concepts.

7. Sixty percent students thought that the Open-Ended questions in MEN were properly mentioned.

**Step VIII: Main Study:**

This was done in following manner.

1. Group of 60 students of upper primary level was selected from each school. (Appendices Q₁ and Q₂)
2. Marks of last semester examination of these students were collected.

3. On the basis of last semester examination marks, four equivalent groups were made in two different schools. (i.e. four groups) (Appendices Q₁ and Q₂)

4. Two groups were controlled and another two were treated as an experimental group.

5. Pre-test was given to one group from controlled and one from experimental and results were drawn.

6. Prepared MEN was given to one group from controlled and one from experimental. Traditional method was applied for teaching to remaining one group from controlled and one from experimental.

7. Post-test was given to remaining one group from controlled and one from experimental and results were drawn.

8. According to data, effectiveness of the MEN was calculated.

   The diagrammatic presentation of conducted main study is shown as bellow.

![Diagrammatic Presentation of Main Study](image)

Fig. 3.9

Diagrammatic Presentation of Main Study
3.6 DEVELOPMENT OF MATHEMATICS EXPERIMENT NOTEBOOK:

The researcher prepared questionnaire for experienced Mathematics teachers who were teaching to upper primary level and for research experts. He also prepared opinionnaire for the experienced school teachers. The teachers gave the valuable suggestions for the MEN.

The analysis was done on the following basis.

1. Analysis of questionnaire of experienced Mathematics school teachers for present position of teaching Mathematics. (Appendix C)

2. Analysis of opinionnaire about Mathematics Experiment Notebook by experienced school teachers. (Appendix H)


4. Analysis of questionnaire about Mathematics Experiment Notebook by research experts. (Appendix I)

5. Suggestions given by research experts.

The data was collected and analysed through questionnaire and opinionnaire.

3.7 ESTABLISHING STABILITY:

The testing takes place when the task is considered as a working model. This means though it is not finished, it is functional, and provides a clear idea of the way the final product will be appeared. Since the product to be evaluated is still in the development stage. The purpose of the establishing stability is to determine if the general direction and structure are adequate and what changes are necessary. For this purpose, validity of Mathematics Experiment Notebook was calculated.

3.8 VALIDITY OF MATHEMATICS EXPERIMENT NOTEBOOK:

Validity refers to accuracy with which a tool measures whatever it is supposed to measure. Test validity and test purpose is closely related. A test is said to be valid if it meets the purpose for which it is designed.
Validity is that quality of data gathering instrument or procedure that enables it to measure what it was supposed to measure. Validity refers to the degree to which evidence and theory support the interpretation of test scores required by proposed uses of test. (Soti and Sharma, Research in Education, 2002, pp 364)

**Experimental Validity:**

Content validity is the representative or sampling adequacy of the content, the substance the matter and the topics of a measuring instrument. (Mark, 1996, pp 289)

To make a significant contribution to the development of knowledge, an experiment must be valid. Campbell and Stanley (1966) describe two types of experimental validity i.e. internal and external validity. Cook and Campbell (1979) further divided experimental validity, adding two other types i.e. statistical and construct validity. (John Best and James Kahn, 2011, pp 171)

### 3.8.1 CONTROLS FOR INTERNAL VALIDITY:

In educational experiments, a number of extraneous variables are present in the situation or are generated by the experimental design and procedures. These variables influence the result of the experiment in any ways that are difficult to evaluate. In a sense, they introduce rival hypotheses that could account for experimental change not attributable to the experimental variables under consideration. Although these extraneous variables usually cannot be completely eliminated, many of them can be identified. It is important that behavioral researches anticipate them and take all possible precautions to minimize their influence through sound experiment design and execution. (John w. Best and James V. Kahn, 2011, pp 171, 172)

The eight classes of extraneous variables identified by Campbell and Stanley (1966), which functions as the sources of invalidity are-

1. History
2. Maturation.
3. Testing.
4. Instrumentation.
5. Regression.
7. Mortality
8. Interaction of Selection and Maturation.

3.8.1.1 History:

History refers to events occurring in the environment at the same time that the experimental variable is being tested. Specifically, Materials, Conditions and procedure used within the experiment except of the variables manipulated must be identical.

A control group located in the same environment of the experimental groups was selected as a part of the study and it took care of History.

3.8.1.2 Maturation

Maturation refers to the processes of change within the experimental subjects as fatigue, hunger, loss of interest. The changes are biological and psychological from within and external sources as location, duration of experiment etc.

As the duration of the experiment was just 30 days there was small possibility of biological changes in the students which might have affected dependent variables.

As the experiment was conducted during the school hours, and precaution was taken to take the same period as given in the time table, so it looked like a routine work for students. There was no additional workload on students, so they fully cooperated in the experiment.

The control group set also had the same maturational and developmental experience. Thus, maturation was controlled.

3.8.1.3 Testing:

Testing refers to the effects of taking a pre-test on post-test-performance of individuals if the tests are identical. This factor was taken care of by selecting Solomon four groups design in which there was no pre-test for one group from control and one group from experimental group.
3.8.1.4 **Instrumentation:**

Instrumentation refers to changes that occur in the measurement or observation procedures during an experiment. Changes may occur in the basis of rating from one group to another or testing conditions. To control instrumentation, the researcher provided developed material, model lesson plan and lesson observation schedule to school teachers.

3.8.1.5 **Regression:**

When groups are chosen on the basis of extreme scores on a particular variable, problems of statistical regression occur. The lack of perfect correlation is due to the unreliability of tests.

The groups of extreme scores were not selected. The sample was not purposive, it was random, and hence, there was no problem of regression.

3.8.1.6 **Selection:**

That means biases resulting from differences in the selection of subjects in the compared groups as personal reactions and behaviors of individuals.

The problems of selection were minimized by random selection of the groups to experimental and control group.

3.8.1.7 **Mortality:**

It is related to the loss of subjects during an experiment and also the condition of the experiment.

In order to check mortality personal appeal was made to the students included in the experiment and their consent was sought. Then it was also pointed out to them that the work done for the experiment will be counted as a part of their tests and it would not be an additional work. This helped to maintain high motivation level in both the groups and no student left the experiment till its end.
3.8.1.8 Interaction of Selection and Maturation:

Interaction effects are attributable to selection and maturation affects internal validity. A source of invalidity might be a selection, maturation and interaction.

The duration of the experiment for both the groups was very short i.e. 30 days (August 2nd to September 1st, 2010) similarly for the control group. Thus, most of the combined sources of invalidity of selection and maturation were controlled.

Internal validity only shows that you have evidence to suggest that a programme or study had some effect on the observations and results. Internal validity says nothing about whether the results were what you expected, or whether generalization is possible.

3.8.2 CONTROLS FOR EXTERNAL VALIDITY:

Educational researchers are primarily concerned with practical uses of their findings; they frequently conduct their studies in real classroom situations. While these real life settings present opportunities for greater generalization; they do not automatically result in externally valid research. Campbell and Stanley (1966) also discussed the factors that may lead to reduced generalisability of research to other settings, persons, variables, and measurement instruments. (John w. Best and James V. Kahn, 2011, pp 175)

Campbell and Stanley (1966) used the term ‘external validity’ to refer to the generalisability or representativeness of the study. Four factors are related to external validity. They are –

1. Interaction of Testing and Treatment
2. Interaction of Selection and Treatment
3. Reactive Arrangements.
4. Multiple Treatment Interference
3.8.2.1 Interaction of Testing and Treatment:

Pre-effect may have effects confused or confounded with treatment effect and can be engender attitudes and intellectual skills which would remain latent without the occurrences of posttest.

In the present study, pre-test was used for one group and remaining one group didn’t receive any pre-test from control and experimental group respectively, so effects of interaction of testing and treatment were out of question.

3.8.2.2 Interaction of Selection and Treatment:

External validity is threatened when there is a combination of two factors

(a) A question about representativeness of the sample, and

(b) A possibility of interaction between treatment and subjects, settings and times.

The selected sample is representative and has been ensured through use of an appropriate sampling procedure and it was further demonstrated through empirical comparisons. Thus, the interaction effects of selection and treatment were eliminated.

3.8.2.3 Reactive Arrangements:

The arrangement of the experiment or the experience of participating in it may create sufficient artificiality. But the question is whether it is possible in practice to obtain permission to assign subjects randomly. Subjects may often be reluctant to grant permission because of their concern about possible inconvenience and disruption of work, or their doubts about value of the treatments. Moreover, superior achievement of experimental group may be attributable to the novelty of method of instruction and motivation.

To avoid the effects of these extraneous factors care was taken that experimental group as well as control group were accommodated in a similar situation. Above all, a random sampling and assigning groups to treatments randomly can be remedy for all such threats.
3.8.2.4 Multiple Treatment Interface:

It is more difficult to avoid differences in the desirability of different treatments in a study. To avoid the effects, detailed description of each treatment implemented is given below. (John w. Best and James V. Kahn, 2011, pp 172 to 176)

Having selected the design with a rationale and the ways to control threats to internal and external validity, the variables involved in the study were identified and finalized.

3.9 DEVELOPED MEN:

The small-scale try-out of the prototype helped the researcher in improving the MEN before its implementation. As the overall impact of the prototype was found faithful, it was not found necessary to improve the entire prototype in total.

Successful development of Mathematics Experiment Notebook requires careful planning, as well as comprehensive and effective production management. It is the result of the integrated work of a team.

The small-scale try-out of the prototype also helped the researcher in formulating research and testing the null hypotheses of the final experiment.

3.10 IMPLEMENTATION OF REVISED MATHEMATICS EXPERIMENT NOTEBOOK:

Implementation of the Mathematics Experiment Notebook was a function of putting revised and total validated instructional system into main study. Implementation means experimentation in case of the present study.

3.11 QUESTIONNAIRE:

The researcher prepared the questionnaire for experienced school teachers who were teaching Mathematics to upper primary classes. Questionnaire covered all questions related to the survey of present system of Mathematics teaching. There were two sections in the questionnaire.
Section A was personal information of respondent. Section B was related with present system of Mathematics teaching.

Another questionnaire was prepared for research experts to analyse the developed Mathematics Experiment Notebook.

The questionnaire was framed with the help of experienced school teachers and research experts. Suggestions were collected and improvement was done in the questionnaire.

3.12 **OPINIONNAIRE:**

An opinionnaire was one of the tools that based on Mathematics Experiment Notebook for experienced school teachers. The researcher prepared the opinionnaire to analyse the Mathematics Experiment Notebooks.

An opinionnaire was framed with the help of experts and suggestions were collected and improvement was done.

Likert type scale was developed to find out the opinions about the MEN, while framing the MEN the following points were taken into consideration.

Collect a number of statements about a subject. The correctness of the statements is not important as long as they express opinions held by a substantial number of people.

It is important that they express definite favorableness or unfavorableness to a particular point of view and that the number of favorable and unfavorable statements is approximately equal.

After the statements were collected, a trail test was administered to a number of subjects. Only those items that correlated with the total test were retained. This testing for internal consistency helped to eliminate statements that were ambiguous or that were not of the same type as the rest of the scale. (J. W. Best, 2011, pp 330)

The opinion scale was analyzed by indicating percentage responses for each individual statement. The collected data were analysed in the next chapter IV.
3.13 INTERVIEW:

Interview of the students was one of the techniques used in the present study. It is the general tendency of people that they are usually more willing to talk than to write. The researcher can take advantage to this tendency by using interview technique.

There are two types of interviews such as structured and unstructured interviews. The interview in the present study taken by the researcher was the structured and focused one. The structured and open questions were involved in the interview. The main focus of the interview was on the MEN and its validity and correctness. This area of exploration was predetermined. The interviewees were the ten students. Interviewer was the researcher himself.

3.14 ACHIEVEMENT TESTS (PRE TEST AND POST TEST):

Investigator developed achievement tests, on specific units in Mathematics to assess the student’s performance in Mathematics.

These achievement tests were constructed and administered on two equivalent groups of the students. The same achievement test was used as pre and posttest in experiment (Appendices F₁, F₂ and F₃).

The main objective of the pretest was to examine the achievement level of the students before the treatment. The same test was administered on two groups as a posttest. The main objective of the posttest was to examine the achievement level of the students after the treatment.

Achievement test was consisted with 50 Marks. Achievement test was constructed as follows.

Achievement Test for Standard VI

The achievement test was conducted for Standard VI of 50 marks and the time given for it was 60 min. This test consisted of Objective and short answer type Questions. Essay type questions were not included to avoid subjectivity in assessment.
TABLE 3.10
WEIGHTAGE TO OBJECTIVES FOR STD. VI

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Objectives</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>Comprehension</td>
<td>16</td>
<td>32</td>
</tr>
<tr>
<td>3</td>
<td>Application</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>Skill</td>
<td>14</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>50</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

The 16% weightage was given to knowledge level, while 32% weightage was given to Comprehension, 24% to application level and 28% weightage was given to skill.

The Type of Question Dimension – The weightage according to Type of Questions is give in Table No –3.11

TABLE 3.11
WEIGHTAGE TO TYPE OF QUESTIONS FOR STD. VI

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Type Of Questions</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Objective</td>
<td>28</td>
<td>56</td>
</tr>
<tr>
<td>2</td>
<td>Short Answer</td>
<td>22</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>50</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Objective questions were given weightage of 56% while 44% weightage was given to short answer type questions.

The content Dimension – The weightage according to sub units is give in Table No –3.12
In order to have the total picture of achievement test, blue print was prepared which was put in Appendix E.

Achievement Test for Standard VII

The achievement test was conducted for Standard VII of 50 marks and the time given for it was 60 min. This test consisted of Objective and short answer type Questions. Essay type questions were not included to avoid subjectivity in assessment.

TABLE 3.13

WEIGHTAGE TO OBJECTIVES FOR STD. VII

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Objectives</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>Comprehension</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>Application</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>Skill</td>
<td>16</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

The 14% weightage was given to knowledge level, while 30% weightage was given to Comprehension, 24% to application level and 32% weightage was given to skill.
The Type of Question Dimension – The weightage according to Type of Questions is give in Table No – 3.14

**TABLE 3.14**

WEIGHTAGE TO TYPE OF QUESTIONS FOR STD. VII

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Type Of Questions</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Objective</td>
<td>22</td>
<td>44</td>
</tr>
<tr>
<td>2</td>
<td>Short Answer</td>
<td>28</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>50</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Objective questions were given weightage of 44% while 56% weightage was given to short answer type questions.

The content Dimension – The weightage according to sub units is give in Table No – 3.15

**TABLE NO. 3.15**

WEIGHTAGE TO CONTENT FOR STD. VII

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Name of sub unit</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Properties of Triangle</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>Pythagoras Theorem</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Construction</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>Properties of Various Quadrilateral</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>Congruence</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>Identity</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>7</td>
<td>Graph</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>8</td>
<td>Mensuration</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>Properties of Circle</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>50</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

In order to have the total picture of achievement test, blue print was prepared which was put in Appendix E.

**Achievement Test for Standard VIII**

The achievement test was conducted for Standard VIII of 50 marks and
the time given for it was 60 min. This test consisted of Objective and short answer type Questions. Essay type questions were not included to avoid subjectivity in assessment.

**TABLE 3.16**

**WEIGHTAGE TO OBJECTIVES FOR STD. VIII**

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Objectives</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Comprehension</td>
<td>21</td>
<td>42</td>
</tr>
<tr>
<td>3</td>
<td>Application</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>Skill</td>
<td>16</td>
<td>32</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>50</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

The 10% weightage was given to knowledge level, while 42% weightage was given to Comprehension, 16% to application level and 32% weightage was given to skill.

The Type of Question Dimension – The weightage according to Type of Questions is given in Table No – 3.17

**TABLE 3.17**

**WEIGHTAGE TO TYPE OF QUESTIONS FOR STD. VIII**

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Type Of Questions</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Objective</td>
<td>09</td>
<td>18</td>
</tr>
<tr>
<td>2</td>
<td>Short Answer</td>
<td>41</td>
<td>82</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>50</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Objective questions were given weightage of 18% while 82% weightage was given to short answer type questions.

The content Dimension – The weightage according to sub units is given in Table No – 3.18
TABLE NO.3.18
WEIGHTAGE TO CONTENT FOR STD. VIII

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Name of sub unit</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Parallel Lines &amp; Properties with transversal</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>Area of Various Quadrilateral</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Construction</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>Properties of Circle</td>
<td>17</td>
<td>34</td>
</tr>
<tr>
<td>5</td>
<td>Graph</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>Mensuration</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>50</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

In order to have the total picture of achievement test, blue print was prepared which was put in Appendix E.

3.15 RELIABILITY AND VALIDITY OF THE TOOLS:

Reliability and validity was the important characteristics of the measuring tools. Validity refers to accuracy with which a tool measures whatever it is supposed to measure. Test validity and test purpose is closely related. A test is said to be valid if it meets the purpose for which it is designed.

Reliability is another important characteristic of a measuring instrument. The reliability of a test or any measuring instrument depends upon the consistency with which it measures whatever is supposed to measure. A reliable test is one, which measures accurately and consistently. If a reliable test is given two or three time to the same group, each individual in the group should get approximately the same scores on all occasions. Reliability is a statistical concept and can be calculated by using statistical formula. There are various methods of establishing the reliability such as test-retest method, split method, parallel form method and method of rational equivalence.

The experts established face and content validity of the questionnaires, opinionnaire, interview schedule and achievement tests through analysis.
3.15.1 VALIDITY AND RELIABILITY OF THE QUESTIONNAIRE:

First the researcher prepared the three point scaled opinionnaire having twelve statements. The validity of the tool questionnaire was established through an experienced school teachers and careful analysis by experts having more than fifteen years experience. The researcher explained the purpose of the questionnaire situation upon which the tool is supposed to be based, content needed and asked the experts to evaluate the form of the questionnaire, structure, questions, language, weightage to different aspects of the content needed. Corrections were done according to suggestions. Thus face and content validity of the questionnaire were established. As it is subjective decisions, it cannot be expressed in statistical terms.

The reliability of the questionnaire was established by administering the tool on sample under study (10 teachers and 4 research experts) and gain on sub-sample (5 teachers and 2 research experts) of the sample. The responses at the two occasions were compared and reliability was established. Questionnaire was found moderately reliable.

The poor item was discussed with the experienced school teachers and experts then they were modified, improved or replaced. As per the suggestions of the experts, the final draft of five points scaled and having ten statements was kept ready to test the validity and accuracy of the MEN.

3.15.2 VALIDITY AND RELIABILITY OF THE OPINIONNAIRE:

First the researcher prepared the three point scaled opinionnaire having twelve statements. Then it was checked by two experts for determining the appropriateness of the statements and then tryout was taken for content validity.

The poor item was discussed with the experts and then they were modified, improved or replaced. Then as per the suggestions of the experts, the final draft of five points scaled and having ten statements was kept ready to measure the opinions.

3.15.3 VALIDITY OF THE INTERVIEW:

The face and content validity of the interview schedule were established through the three experts by careful analysis. The researcher explained the purpose of schedule and content involved in the questions. The researcher asked to the experts to
evaluate various questions in interview schedule for their validity against purpose, weightage to different aspects and language.

To test the validity of the interview the researcher discussed about the exploration with his colleagues. Then he requested to his colleagues to take interviews of students with keeping in view the area of focus. Later after a week the researcher took the interview of same students for the same areas. The response got from both the interview was same. The validity of interview was tested.

Reliability was evaluated by restating questions in slightly different from at a later time in the interview. Thus the critical and focused area was finalized and the tool of interview was developed.

3.15.4 VALIDITY AND RELIABILITY OF THE ACHIEVEMENT TESTS:

The achievement test was one of the tools, which were used in the study and have face and content validity. Ten experts confirmed the face validity of the achievement test through careful observation. Ten experienced school teachers and three research experts established the content validity of achievement test through careful analysis of objectives and actual subject matter. The researcher explained the main purpose of the achievement test, content involved in the test, objectives to be tested and asked the experts to evaluate various items in the test for their validity against purpose, content analysis and weightage, language, difficulty level, weightage to objectives and types of question. In this way content validity of the achievement test was established and it was found high.

Construction:

According to Best and Kahn (2011), achievement tests attempt to measure what an individual has learned- his or her present level of performance. Most tests used in schools are achievement tests. They are particularly helpful in determining individual or group status in academic learning. Achievement test scores are used in placing, advancing, or retaining students at particular grade levels. They are used in diagnosing strengths and weaknesses and as a basis for awarding prizes, scholarships, or degrees. Many of the achievement tests used in schools are nonstandardised, teacher-designed tests. There is a national movement to have standards that would be
measured by standardised tests, some in existence but others that would need to be developed.

In research, achievement tests scores are used frequently in evaluating the influences of courses of study, teachers, teaching methods, and other factors considered to be significant in educational practice. In using tests for evaluating purposes, researchers must remember not to generalize beyond the specific elements measured. (Best, J.W. and J.V. Kahn: 2011, pp.301)

In order to make the achievement tests more accurate and embracing, blue-prints (Appendix E) were strictly prepared before constructing the achievement tests. It had three dimensions –

1)'Objective' dimension.

2)'Content' dimension.

3)'Type of questions' dimension.

Each test was of 50 marks for each class. The objectives taken into consideration at the test of Mathematics content were –I) Knowledge II) Comprehension III) Application IV) Skill

Content Validity:

The constructed achievement tests were given to experienced school teachers for their opinion. They made following suggestions.

(1) Questions should be in appropriate language.

(2) Alternatives should be of same length and type.

(3) Questions should be precise, sharp / pointed.

Reliability:

The achievement tests were given to 60 students to solve who were not involved in the experiment. After completing the test, time was calculated individually. Then by summing time of 60 students mean was calculated. Time for these achievement tests was of 60 minutes.
Thus, the achievement tests were constructed and standardized (Appendices F₁, F₂ and F₃). The researcher used this achievement test tool to find out the achievement of the students in both the groups involved in the study.

The same achievement tests were used as pre and post-test in experiment. The achievement tests were administered on two equivalent groups of the students.

The main objective of the pre-test was to examine the achievement level of the students before the treatment. The main objective of the post-test was to examine the achievement level of the students after the treatment.

3.16 EQUIVALENT GROUP FORMATION:

Marks obtained in the last semester in Mathematics by the selected students were taken into consideration to make comparable groups. The scores obtained were arranged according to descending order. To form equivalent groups, the students were distributed in two groups as follows.

**TABLE 3.19**

FORMATION OF EQUIVALENT GROUPS

<table>
<thead>
<tr>
<th>Schools →</th>
<th>AKVS</th>
<th></th>
<th></th>
<th>MSVS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sr. No</td>
<td>Group 1</td>
<td>Group 2</td>
<td>Sr. No</td>
<td>Group 1</td>
<td>Group 2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
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<tr>
<td>2</td>
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<td>3</td>
<td>5</td>
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<td>3</td>
<td>5</td>
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</tr>
<tr>
<td>4</td>
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<td>8</td>
<td>7</td>
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<td>5</td>
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<td>9</td>
<td>10</td>
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<td>11</td>
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<td>7</td>
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<td>8</td>
<td>16</td>
<td>15</td>
<td>8</td>
<td>16</td>
<td>15</td>
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</tr>
<tr>
<td>9</td>
<td>17</td>
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<td>9</td>
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<td>10</td>
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<td></td>
</tr>
<tr>
<td>13</td>
<td>25</td>
<td>26</td>
<td>13</td>
<td>25</td>
<td>26</td>
<td></td>
</tr>
</tbody>
</table>
The researcher observed the marks of each student and made the equivalent group.

Means and standard deviations along with t–test of the scores was calculated and is given below.

**TABLE 3.20**

THE SUMMERY TABLE OF MEANS, SD’S AND T-VALUE OF BOTH THE GROUPS IN THE ACHIEVEMNET TEST ON MATHEMATICS

STD. VI (AKV)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Groups</th>
<th>No. of students</th>
<th>Means</th>
<th>S.D.</th>
<th>t-value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td>30</td>
<td>75.80</td>
<td>6.19</td>
<td>0.29</td>
<td>Not Significant</td>
</tr>
<tr>
<td>2</td>
<td>Experimental</td>
<td>30</td>
<td>75.33</td>
<td>6.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Average Mean</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>75.57</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Required \( t \)-value for the df = 58 is \( 2.66 \) at 0.01 level and \( 2.00 \) at 0.05 level

**Observations and Interpretations:**

1. Mean of control group is 75.80
2. Mean of experimental group is 75.33
3. Average mean of both the groups is 75.57
4. The mean difference is 0.47; there is less difference in the means of both the groups.
5. The S.D.s for control and experimental group are 6.41 and 6.19 respectively. Hence, both the groups do not differ from one another before the use of use of MEN.
6. \( t \)-value is not significant at both the levels.

**Findings:**

Both the groups were comparable so far as their initial performance in Mathematics subject was concerned. It implied that both the groups were matching. i.e. Both the groups were homogeneous.

**TABLE 3.21**

**THE SUMMERY TABLE OF MEANS, SD’S AND T-VALUE OF BOTH THE GROUPS IN THE ACHIEVEMENT TEST ON MATHEMATICS**

**STD. VII (AKV)**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Groups</th>
<th>No. of students</th>
<th>Means</th>
<th>S.D.</th>
<th>( t )-value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td>30</td>
<td>77.10</td>
<td>5.25</td>
<td>0.21</td>
<td>Not Significant</td>
</tr>
<tr>
<td>2</td>
<td>Experimental</td>
<td>30</td>
<td>76.80</td>
<td>5.88</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Average Mean | 76.95 |

Required \( t \)-value for the df = 58 is \( 2.66 \) at 0.01 level and \( 2.00 \) at 0.05 level
Observations and Interpretations:

1. Mean of control group is 77.10
2. Mean of experimental group is 76.80
3. Average mean of both the groups is 76.95
4. The mean difference is 0.3; there is less difference in the means of both the groups.
5. The S.D.s for control and experimental group are 5.88 and 5.25 respectively. Hence, both the groups do not differ from one another before the use of use of MEN.
6. t-value is not significant at both the levels.

Findings:

Both the groups were comparable so far as their initial performance in Mathematics subject was concerned. It implied that both the groups were matching, i.e. Both the groups were homogeneous.

TABLE 3.22

THE SUMMERY TABLE OF MEANS, SD’S AND T-VALUE OF BOTH THE GROUPS IN THE ACHIEVEMENT TEST ON MATHEMATICS

STD. VIII (AKV)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Groups</th>
<th>No. of students</th>
<th>Means</th>
<th>S.D.</th>
<th>t-value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td>30</td>
<td>78.40</td>
<td>6.03</td>
<td>0.72</td>
<td>Not Significant</td>
</tr>
<tr>
<td>2</td>
<td>Experimental</td>
<td>30</td>
<td>77.20</td>
<td>6.86</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Average Mean 77.80

Required t-value for the df = 58 is 2.66 at 0.01 level and 2.00 at 0.05 level

Observations and Interpretations:

1. Mean of control group is 78.40
2. Mean of experimental group is 77.20
3. Average mean of both the groups is 77.80
4. The mean difference is 1.2; there is less difference in the means of both the groups.

5. The S.D.s for control and experimental group are 6.80 and 6.03 respectively. Hence, both the groups do not differ from one another before the use of use of MEN.

6. t-value is not significant at both the levels.

**Findings:**

Both the groups were comparable so far as their initial performance in Mathematics subject was concerned. It implied that both the groups were matching. i.e. Both the groups were homogeneous.

**TABLE 3.23**

THE SUMMERY TABLE OF MEANS, SD’S AND T-VALUE OF BOTH THE GROUPS IN THE ACHIEVEMNET TEST ON MATHEMATICS

STD. VI (MSVS)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Groups</th>
<th>No. of students</th>
<th>Means</th>
<th>S.D.</th>
<th>t-value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td>30</td>
<td>77.90</td>
<td>5.39</td>
<td>0.56</td>
<td>Not Significant</td>
</tr>
<tr>
<td>2</td>
<td>Experimental</td>
<td>30</td>
<td>77.13</td>
<td>5.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Average Mean</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>77.52</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Required t-value for the df = 58 is 2.66 at 0.01 level and 2.00 at 0.05 level

**Observations and Interpretations:**

1. Mean of control group is 77.90
2. Mean of experimental group is 77.13
3. Average mean of both the groups is 77.52
4. The mean difference is 0.77; there is less difference in the means of both the groups.
5. The S.D.s for control and experimental group are 5.39 and 5.17 respectively. Hence, both the groups do not differ from one another before the use of use of MEN.
6. t-value is not significant at both the levels. Hence, H 4.7.0 is accepted.
Findings:

Both the groups were comparable so far as their initial performance in Mathematics subject was concerned. It implied that both the groups were matching. i.e. Both the groups were homogeneous.

**TABLE 3.24**

THE SUMMERY TABLE OF MEANS, SD’S AND T-VALUE OF BOTH THE GROUPS IN THE ACHIEVEMENT TEST ON MATHEMATICS

STD. VII (MSVS)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Groups</th>
<th>No. of students</th>
<th>Means</th>
<th>S.D.</th>
<th>t-value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td>30</td>
<td>77.53</td>
<td>4.79</td>
<td>0.66</td>
<td>Not Significant</td>
</tr>
<tr>
<td>2</td>
<td>Experimental</td>
<td>30</td>
<td>76.67</td>
<td>5.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average Mean</td>
<td></td>
<td>77.10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Required t-value for the df = 58 is 2.66 at 0.01 level and 2.00 at 0.05 level

Observations and Interpretations:

1. Mean of control group is 77.53
2. Mean of experimental group is 76.67
3. Average mean of both the groups is 77.10
4. The mean difference is 0.86; there is less difference in the means of both the groups.
5. The S.D.s for control and experimental group are 4.79 and 5.23 respectively. Hence, both the groups do not differ from one another before the use of MEN.
6. t-value is not significant at both the levels.
Findings:

Both the groups were comparable so far as their initial performance in Mathematics subject was concerned. It implied that both the groups were matching, i.e. Both the groups were homogeneous.

**TABLE 3.25**

THE SUMMERY TABLE OF MEANS, SD’S AND T-VALUE OF BOTH THE GROUPS IN THE ACHIEVEMENT TEST ON MATHEMATICS

STD. VIII (MSVS)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Groups</th>
<th>No. of students</th>
<th>Means</th>
<th>S.D.</th>
<th>t-value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td>30</td>
<td>77.90</td>
<td>4.91</td>
<td>0.96</td>
<td>Not Significant</td>
</tr>
<tr>
<td>2</td>
<td>Experimental</td>
<td>30</td>
<td>76.60</td>
<td>5.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average Mean</td>
<td></td>
<td>77.25</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Required t-value for the df = 58 is 2.66 at 0.01 level and 2.00 at 0.05 level

Observations and Interpretations:

1. Mean of control group is 77.90
2. Mean of experimental group is 76.60
3. Average mean of both the groups is 77.25
4. The mean difference is 1.3; Means of both the groups are approximately the same as average mean.
5. t-value is not significant at both the levels.
6. The S.D.s for control and experimental group are 4.91 and 5.54 respectively. Hence, both the groups do not differ from one another before the use of use of MEN.
Findings:

Both the groups were comparable so far as their initial performance in Mathematics subject was concerned. It implied that both the groups were matching. i.e. Both the groups were homogeneous.

After making equivalent groups of each class in both schools, the names to the groups were assigned randomly using lottery method. They are as follow-

For Annasaheb Kalyani Vidyalaya, Satara. Group No.1 - Experimental group.
   Group No. 2 –Control group
For Maharaja Sayajirao Vidyalaya, Satara. Group No. 1-Control group.
   Group No. 2- Experimental group

3.17 ORIENTATION ABOUT TEACHING STRATEGY:

The researcher made the lesson plan (Appendix U) according to the developed Mathematics Experiment Notebooks. That lesson plan was made with the help of research experts and their valuable suggestions. The researcher oriented to the related Mathematics teachers in both schools (Appendix W) before conducting the experiment. The investigator guided those selected teachers on the basis of following points.

Preliminary Discussion:

The researcher discussed in connection with the different ways of conducting experiment based lesson planning.

1. Teacher demonstration.

2. All students working in small teams on the same experiment.

Lesson Planning:

1. The researcher discussed about preparation of the lesson planning.

2. The researcher demonstrated lesson with the help of Mathematics Experiment Notebook in real classroom situation.
3. The researcher conducted discussion on steps of lesson, lesson plan, demonstration lesson and lesson observation sheet (LOS).

4. The researcher provided the Mathematics Experiment Notebook, model lesson plan and lesson observation schedule to school teachers.

5. The researcher arranged the experiments based practice lesson programme me of the selected school teachers in peer group.

6. The school teacher and researcher observed that lesson by lesson observation sheet (LOS).

7. All observers i.e. researcher and school teachers gave the feedback for the practice lesson.

8. The selected teachers were of the same age group with near about same teaching experience of Mathematics teaching at upper primary level. (Appendix W).

   By inter observing evaluation procedure, all selected school teachers comes at the equal level regarding to teaching with the help of MEN.

3.18 STEPS OF CONDUCTING LESSON:

   Teaching Mathematics with the help of MEN should be with minimum of confusion and maximum of learning. For that the teacher must do planning in the following way.

a. **Teacher Demonstration:**

   The teacher firstly states the problem to the class. Then he/she selects materials related to the problem. The teacher demonstrates the experiment as per the procedure. The teacher gets active participation of students whenever needed.

   Teacher demonstrations are useful for teaching how to formulate problems, analyse the problem, collect data, record data and draw conclusions.
b. **Provide the material to students:**

Materials regarding to the experiments should be made available and distribute to students, which was already in kit or easily prepared. In general, this teaching strategy provides for student involvement under the close supervision of the teacher.

c. **Students working as a team in separate activities:**

The teacher instructs to students regarding the use of experiment notebook, related material and evaluates their understanding of the activity.

d. **Evaluation:**

The teacher should be aware of interests aroused by these activities. After completion of the experiment, the teacher gives some task related to experiment as a home assignment.

(Model lesson plan-Appendix U) (Lesson Observation Sheet - Appendix V)

3.19 **LESSON OBSERVATION SHEET (LOS):**

The researcher discussed with research experts and prepared the lesson observation sheet. It had ten statements with five point rating scale. This lesson observation sheet was approved by the experts. Its tryout was taken by observing lessons of two school teachers. Thus the validity of lesson observation sheet (LOS) was tested.

3.20 **CONDUCT OF THE EXPERIMENT :**

After the discussion with the concerned teachers, it was decided to conduct the experiment. The experiment was conducted in the first term in both schools. The actual experiment commenced on 2nd August 2010. This particular period was purposefully chosen for the following reasons.

1. As the experiment was supposed to be carried out during the school hours every day, there was no extra work for the students.
2. It was also suitable for the researcher to follow up the experiment. In these days no lectures were in the college because of the admission process was not completed.

3. The opinions from students about the Mathematics Experiment Programme were collected after the completion of the experiment.

3.21 THE TIME SCHEDULE OF THE EXPERIMENT:

The experiment was conducted during school hours as per the plan made by the school authorities and researcher. Achievement tests were administered without disturbing school schedule.

The Mathematics Experiment Notebook was given to each student which was involved in this experiment. The whole programme was fixed.

The detailed description of the day wise programme is as under.

**TIME TABLE FOR BOTH SCHOOLS FOR STD.VI**

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Date</th>
<th>Experiment Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2nd August 10</td>
<td>HCF</td>
</tr>
<tr>
<td>2</td>
<td>3rd August 10</td>
<td>LCM</td>
</tr>
<tr>
<td>3</td>
<td>4th August 10</td>
<td>Parallel Lines</td>
</tr>
<tr>
<td>4</td>
<td>5th August 10</td>
<td>Parts of Angle</td>
</tr>
<tr>
<td>5</td>
<td>6th August 10</td>
<td>Pairs of Supplementary Angle</td>
</tr>
<tr>
<td>6</td>
<td>7th August 10</td>
<td>Pairs of complementary Angle</td>
</tr>
<tr>
<td>7</td>
<td>9th August 10</td>
<td>Pairs of Linear Angle</td>
</tr>
<tr>
<td>8</td>
<td>10th August 10</td>
<td>Pairs of Opposite Angle</td>
</tr>
<tr>
<td>9</td>
<td>11th August 10</td>
<td>Angles made by parallel lines with transversal</td>
</tr>
<tr>
<td>10</td>
<td>12th August 10</td>
<td>Proportion</td>
</tr>
<tr>
<td>11</td>
<td>13th August 10</td>
<td>Introduction to Algebra</td>
</tr>
<tr>
<td>12</td>
<td>14th August 10</td>
<td>Angle sum property</td>
</tr>
<tr>
<td>13</td>
<td>16th August 10</td>
<td>Exterior angle property</td>
</tr>
<tr>
<td>14</td>
<td>17th August 10</td>
<td>Sum of two sides of a its third side</td>
</tr>
<tr>
<td>15</td>
<td>18th August 10</td>
<td>Construct of a line perpendicular to a given line from a point outside the line.</td>
</tr>
<tr>
<td>Sr.No</td>
<td>Date</td>
<td>Experiment Completed</td>
</tr>
<tr>
<td>-------</td>
<td>------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>16</td>
<td>19th August 10</td>
<td>Construct of a line perpendicular to a given line from a point on the line</td>
</tr>
<tr>
<td>17</td>
<td>20th August 10</td>
<td>Drawing Perpendicular bisector</td>
</tr>
<tr>
<td>18</td>
<td>21st August 10</td>
<td>Drawing Angle bisector</td>
</tr>
<tr>
<td>19</td>
<td>23rd August 10</td>
<td>Drawing Equivalent Angle</td>
</tr>
<tr>
<td>20</td>
<td>24th August 10</td>
<td>Construction of a line parallel to a given line</td>
</tr>
<tr>
<td>21</td>
<td>25th August 10</td>
<td>Constructing bar graphs</td>
</tr>
<tr>
<td>22</td>
<td>26th August 10</td>
<td>Properties of radius and diameter of circle</td>
</tr>
</tbody>
</table>

**Fig. 3.10**

Time Table of Experiments for VI

**TIME TABLE FOR BOTH SCHOOLS FOR STD.VII**

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Date</th>
<th>Experiment Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2nd August 10</td>
<td>Median of Triangle</td>
</tr>
<tr>
<td>2</td>
<td>3rd August 10</td>
<td>Angle bisectors of Triangle</td>
</tr>
<tr>
<td>3</td>
<td>4th August 10</td>
<td>Pythagoras Theorem</td>
</tr>
<tr>
<td>4</td>
<td>5th August 10</td>
<td>Construction of Triangle :Given three sides</td>
</tr>
<tr>
<td>5</td>
<td>6th August 10</td>
<td>Construction of Triangle :Given two sides and between angle</td>
</tr>
<tr>
<td>6</td>
<td>7th August 10</td>
<td>Construction of Triangle :Given two angles and between side</td>
</tr>
<tr>
<td>7</td>
<td>9th August 10</td>
<td>Construction of Right angle Triangle :Given diagonal and one side</td>
</tr>
<tr>
<td>8</td>
<td>10th August 10</td>
<td>Basic concepts of Quadrilateral</td>
</tr>
<tr>
<td>9</td>
<td>11th August 10</td>
<td>Angle sum property of Quadrilateral</td>
</tr>
<tr>
<td>10</td>
<td>12th August 10</td>
<td>Congruency of Segment</td>
</tr>
<tr>
<td>11</td>
<td>13th August 10</td>
<td>Congruency of Angle</td>
</tr>
<tr>
<td>12</td>
<td>14th August 10</td>
<td>Congruency of triangles</td>
</tr>
<tr>
<td>13</td>
<td>16th August 10</td>
<td>Congruency of Quadrilateral</td>
</tr>
<tr>
<td>14</td>
<td>17th August 10</td>
<td>Congruency of circles</td>
</tr>
<tr>
<td>15</td>
<td>18th August 10</td>
<td>Properties of square</td>
</tr>
<tr>
<td>16</td>
<td>19th August 10</td>
<td>Properties of rectangle</td>
</tr>
<tr>
<td>17</td>
<td>20th August 10</td>
<td>Properties of rhombus</td>
</tr>
<tr>
<td>18</td>
<td>21st August 10</td>
<td>Properties of parallelogram</td>
</tr>
</tbody>
</table>
### Time Table of Experiments for VII

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Date</th>
<th>Experiment Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; August 10</td>
<td>Parallel Lines and transversal</td>
</tr>
<tr>
<td>2</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt; August 10</td>
<td>Division of Segment</td>
</tr>
<tr>
<td>3</td>
<td>4&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Centre and Chord of Circle</td>
</tr>
<tr>
<td>4</td>
<td>5&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Centre and Congruent Chords</td>
</tr>
<tr>
<td>5</td>
<td>6&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Central Angle and Congruent Chord</td>
</tr>
<tr>
<td>6</td>
<td>7&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Formula of area of parallelogram</td>
</tr>
<tr>
<td>7</td>
<td>9&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Formula of area of rhombus</td>
</tr>
<tr>
<td>8</td>
<td>10&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Formula of area of Trapezium</td>
</tr>
<tr>
<td>9</td>
<td>11&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Construction of Quadrilateral: Given four sides and one diagonal</td>
</tr>
<tr>
<td>10</td>
<td>12&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Construction of Quadrilateral: Three sides and two diagonals</td>
</tr>
<tr>
<td>11</td>
<td>13&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Construction of Quadrilateral: Two adjacent sides and three angles</td>
</tr>
<tr>
<td>12</td>
<td>14&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Construction of Quadrilateral: Three sides and two included angles</td>
</tr>
<tr>
<td>13</td>
<td>16&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Relation between Cone and Arc Of Circle</td>
</tr>
<tr>
<td>14</td>
<td>17&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Properties of Cyclic Quadrilateral</td>
</tr>
<tr>
<td>15</td>
<td>18&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Constructing Joint bar graphs</td>
</tr>
<tr>
<td>16</td>
<td>19&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Surface area of a cylinder</td>
</tr>
<tr>
<td>17</td>
<td>20&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Relation between cylinder and cone</td>
</tr>
</tbody>
</table>

### Time Table of Experiments for VIII

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Date</th>
<th>Experiment Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>23&lt;sup&gt;rd&lt;/sup&gt; August 10</td>
<td>Identity : $(a+b)^2$</td>
</tr>
<tr>
<td>20</td>
<td>24&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Identity : $(a - b)^2$</td>
</tr>
<tr>
<td>21</td>
<td>25&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Identity : $(a + b) (a - b)$</td>
</tr>
<tr>
<td>22</td>
<td>26&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Reading of Joint bar graphs</td>
</tr>
<tr>
<td>23</td>
<td>27&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Surface Area of Cube</td>
</tr>
<tr>
<td>24</td>
<td>28&lt;sup&gt;th&lt;/sup&gt; August 10</td>
<td>Angles in the semicircle</td>
</tr>
</tbody>
</table>

---

**Fig. 3.11**

**TIME TABLE FOR BOTH SCHOOLS FOR STD.VIII**

---

**Fig. 3.12**

**Time Table of Experiments for VIII**
3.22 **COLLECTION OF DATA:**

The data were collected with the help of various tools and techniques in the following way:

1. Opinions and suggestions given by experienced Mathematics teacher with the help of the Questionnaire.
2. Opinions and suggestions given by experienced school teachers (content expert) on Mathematics Experiment Notebook with the help of Opinionnaire.
3. Opinions and suggestions given by research expert on Mathematics Experiment Notebook with the help of Questionnaire.
4. Scores obtained in an Achievement Tests (Pre Test and Post Test) on the student’s performance in Mathematics in Pilot Study.
5. Scores obtained in an Achievement Tests (Pre Test and Post Test) on the student’s performance in Mathematics in Main Study.
6. Information was collected through Interview Schedule of students.

3.23 **STATISTICAL TREATMENT:**

The data were collected and analyzed with the help of following statistical treatments.

**Correlated Analysis (F-test):** To see the relation between pre and post test achievement.

**‘t’ test:** To test the significance of difference between means and standard deviations.

3.24 **CONCLUDING REMARKS:**

In the foregone pages the researcher has explained the procedure he has used in the development of the Mathematics Experiment Notebook that he has constructed.

This chapter deals with the procedure for the present research work. The researcher has described the various steps taken for the development various tools including MEN and also mentioned sample selection procedure, statistical formulae for the analysis of data.

The researcher conducted the experiment on the sample under study. He used valid and reliable tools in collecting data. The detailed analysis and interpretation of data collected from the experimentation were explained in chapter IV.