CHAPTER FIFTH

SUMMARY, CONCLUSION, RECOMMENDATIONS AND SUGGESTIONS

5.0 INTRODUCTION:

Taking into consideration the national aspirations and expectations reflected in the recommendations of the National Curriculum Framework developed by NCERT, the Central Board of Secondary Education had initiated a number of steps to make teaching and learning of mathematics at school stage activity-based and experimentation oriented. In addition to issuing directions to its affiliated schools to take necessary action in this regard, a document on ‘Mathematics Laboratory in Schools – towards joyful learning’ was brought out by the Board and made available to all the schools. The document primarily aimed at sensitizing the schools and teachers to the concept of Mathematics Laboratory and creating awareness among schools as to how the introduction of Mathematics Laboratory will help in enhancing teaching-learning process in the subject from the very beginning of school education. The document also included a number of suggested hands-on activities.

The general observation of the researcher is that Mathematics has been the result making subject at the S.S.C. and H.S.C. examination. The failure percentage of students in Mathematics subject remains a point to think over. To fulfill the objectives of the course book, there should be three main principles

i. ‘Learning by doing’,

ii. ‘Learning by observation’, and

iii. Proceeding from concrete to abstract.

As per the nature of the course book, wording and language of the content is based on practical method. NCERT published New Curriculum framework in 2001 focusing on Mathematics laboratory. This framework indicates that Mathematics laboratory should have a place in the science laboratory.
Keeping in mind all such things, the researcher has been encouraged to develop such a Mathematics Experiment Notebook that would enhance the pupils to learn Mathematics in a better way which ultimately affect their achievement in Mathematics positively.

This chapter deals with the outcomes of the experiment based on the findings of the study by testing the hypotheses as per objectives formulated for the study or results or conclusions drawn from them. It also includes the brief summary of the study. It includes implications of this research for all those who are concerned with the process of education, in various capacities and a few suggestions for further study in this field.

5.1 NEED OF THE STUDY:

This study is useful to secondary teachers who are teaching Mathematics. At the same time, this study is also useful to students who are studying in upper primary classes because it makes them understand Mathematics concepts with ease.

5.2 STATEMENT OF THE PROBLEM:

The statement of the problem for research was stated in the following words.

“DEVELOPMENT OF MATHEMATICS EXPERIMENT NOTEBOOK FOR TEACHING UPPER PRIMARY SCHOOL PUPILS – A STUDY.”

5.3 DEFINITIONS OF THE TERMS:

The conceptual and operational definitions of the terms used in the statement of the problem are defined below for the sake of clarity and also for delimiting the scope of study as follows:

A) CONCEPTUAL DEFINITIONS:

1. Development:

   1. The systematic use of scientific and technical knowledge to meet specific objectives or requirements.
2. An extension of the theoretical or practical aspects of a concept, design, discovery, or invention. (Oxford English Dictionary: 1933).

2. **Mathematics:**

1. The abstract science which investigates deductively the conclusions implicit in the elementary conceptions of spatial and numerical relations, and which includes as its main divisions geometry, arithmetic, and algebra. (Oxford English Dictionary: 1933).


3. Mathematics is the science of structure, order, and relation that has evolved from elemental practices of counting, measuring, and describing the shapes of objects. (Encyclopedia Britannica: 2010).

3. **Achievement:**

1. A standardized test used to assess knowledge and skill in any subjects.

2. Performance appraisal test that measures the extent to which a trainee has acquired certain information, or has mastered the required skills. (Encyclopedia Britannica: 2010)

**B) OPERATIONAL DEFINITIONS:**

The operational definitions of the terms used in the statement of the problem are defined below for the sake of clarity and also for delimiting the scope of study as follows:

1. **Development:**

The term development includes planning, designing, constructing and the testing of an instructional system.

2. **Mathematics Experiment Notebook (MEN):**

It is a Mathematics Experiment Notebook consisting of teaching learning material includes aim of experiment, procedure, observation table, calculation, diagram and conclusion i.e. Mathematical principles or properties
etc. developed for the learners in order to assist them in the comprehension of certain mathematical concepts.

3. **Mathematics:**
   One of the basic subjects at Upper Primary School Level.

4. **Achievement:**
   Marks obtained by the pupils in Upper Primary classes in Achievement Test.

5. **Upper Primary School:**
   The Middle Stage of education comprises Classes VI-VIII. The Classes V-VIII constitutes the Upper Primary School Level.

5.4 **OBJECTIVES OF THE STUDY:**

The general and the specific objectives of the study are as follows –

a. **General Objectives**
   1. To develop a Mathematics experiment notebooks to teach Mathematics to Upper Primary classes.
   2. To study the efficacy of the Mathematics Experiment Notebooks developed by the researcher in terms of pupils achievement.

b. **Specific Objectives**
   1. To analyse the textbook of upper primary classes in order to locate areas suitable for developing Mathematics Experiment Notebooks.
   2. To determine the teaching strategy in accordance with developed Mathematics Experiment Notebooks.
   3. To compare the effectiveness of developed Mathematics Experiment Notebooks with the conventional system of instruction.
   4. To study the comparative effect of developed Mathematics Experiment Notebooks in terms of the pupils’ achievement in knowledge, comprehension, application and skill.
5.5 HYPOTHESES OF THE STUDY:

Research Hypothesis

Teaching Mathematics with MEN affects pupils’ achievement in Mathematics.

Null Hypotheses

1. There is no significant difference between the achievement score of the students from control and experimental group in knowledge, taught by using MEN and that with conventional method.

2. There is no significant difference between the achievement score of the students from control and experimental group in comprehension taught by using MEN and that with conventional method.

3. There is no significant difference between the achievement score of the students from control and experimental group in application taught by using MEN and that with conventional method.

4. There is no significant difference between the achievement score of the students from control and experimental group in skill taught by using MEN and that with conventional method.

5. There is no significant difference between the performances of the students from control group in knowledge, comprehension, application and skill in pre over post-testing.

6. There is no significant difference between the performances of the students from experimental group in knowledge, comprehension, application and skill in pre over post-testing.

7. There is no significant difference in the mean achievement of the students by using MEN and conventional instructional system.

8. There is no significant difference between the performances of the students from upper primary classes by using MEN.

9. There is no significant difference between the performances of the students in knowledge, comprehension, application and skill from upper primary classes by using MEN.
5.6 DELIMITATIONS OF THE STUDY:

The scope of this study was covering Mathematics subjects at Upper Primary classes in Marathi language to teaching pupils in Maharashtra. The Mathematics Experiment Notebooks were useful not only the teachers but also students of Upper Primary classes in Marathi medium.

However, the present study has the following delimitations.

1. The present study is limited only to the students of Upper Primary classes.
2. The present study is related only to the urban area that is Satara city.
3. The research is limited for the subject Mathematics of Upper Primary classes.
4. The study is limited to the students who are studying in Upper Primary classes in the Maharashtra State Education Pattern 10+2+3.
5. The study is delimited to specific units i.e. arithmetic, area, volume, similarity, congruency etc. of Upper Primary classes for Mathematics subject.

5.7 DEVELOPMENT AND RESEARCH PROCEDURE:

The research procedure of the study was explained briefly in the following paragraphs. The details were elaborated in the Chapter III: Plan and Procedure of the research.

5.7.1 RESEARCH PROCEDURE: (In Brief)

The researcher used following procedure to develop Mathematics Experiment Notebooks.

1. The researcher analyzed the present position of teaching Mathematics by experienced school teachers. He collected the data by administering questionnaire to 30 experienced school teachers in various schools. This helped the researcher to understand the present position of teaching Mathematics and helped in developing Mathematics Experiment Notebooks. The outcome of this step was a rough sketch of the Mathematics Experiment Notebooks.

2. The researcher planned and developed the Mathematics Experiment Notebooks for upper primary classes. In this step objectives and content of the MEN were defined.
3. In this production step researcher prepared Mathematics Experiment Notebooks. The internal evaluations of a Mathematics Experiment Notebooks application have done by the research experts and experienced school teachers. After an internal evaluation the Prototype of the proposed product has been made ready for its pilot testing.

4. The testing of the Prototype was an experiment called as Focus group testing or small-scale try – out sample (TOS). It was two group pretest – posttest experimental design. The sample was composed of sixty students of VII standard. The control and experimental group were of 30 students from Annasaheb Kalyani Vidylaya, Satara. A pretest is administered before the implementation of the prototype and the same test was used as posttest after the implementation of the prototype. Pilot study of the Mathematics Experiment Notebooks had done on selected group of students to receive feedback in term of interviews. The data is analyzed and interpreted to collect the information about the effectiveness of prototype.

5. The small-scale try-out of the sample helped the researcher in improving the MEN before its implementation.

6. Main study of the MEN was also an experiment. The Solomon Four-Group Experimental Design is used. The sample was composed of sixty (60) students of upper primary classes from two schools. Each equivalent control and experimental group was of 30 students from respective classes of those schools and that groups were equivalent. The group’s were evaluated by administering pre and post achievement tests.

7. The experiment was conducted within one month, the procedure of which is explained in detail in Chapter III: Plan and Procedure of the research.

5.7.2 EXPERIMENTAL DESIGN:

The researcher used the Pretest-Posttest Equivalent - Groups design in small-scale try out sample (TOS) i.e. for the pilot study. 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 $O_1, O_2=$ pretest, $X =$ Treatment (Mathematics Experiment Notebook), $C =$ Conventional Instructional System, $O_2$, $O_4 =$ posttest.
The Solomon Four-Group Experimental Design: The researcher decided to use the Solomon Four-Group Experimental Design for large-scale try-out of the revised system. The researcher had decided to use this design 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.

1. On the basis of last semester examination marks, four equivalent groups were made in 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 received treatment (C), which was implemented traditionally.
6. One control group received a pre-test (O₃).
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.

5.7.3 SAMPLING DESIGN:

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.

Fox D. J. (1969) has given five steps in a sampling process namely:

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.
5.7.4 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.
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.

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.

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.

![Sampling Procedure Diagram]

**Fig.5.1**

**Sampling Procedure**

**5.7.5 VARIABLES IN THE EXPERIMENT:**

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

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.

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.

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 the 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.

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

Intervening variables:

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

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.: 5.2

Dependent and Independent Variables

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

5.7.6 TOOLS AND TECHNIQUES:

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)
5.7.7 ANALYSIS AND INTERPRETATION OF DATA:

The data were analyzed with the help of statistical and non-statistical measures. The techniques of t test, Analysis of Variance and Covariance were used to test the hypotheses.

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.

5.8 CHAPTERWISE SUMMARY:

The Chapter-wise summary of the study is given below.

**CHAPTER FIRST: INTRODUCTION:**

In this chapter the researcher has discussed about the history of mathematics teaching, importance of mathematics in human life, methods of teaching mathematics, innovative practices in mathematics teaching, and present status of mathematics at upper primary level. After this the chapter throws light on the need and importance of the study. It consists statement of the problem, definition of the terms used; scope and delimitations of the study, objectives of the study, assumptions of the study and hypotheses stated by researcher are also given in this chapter. At the end this chapter concludes with the significance of the study and organisation of chapters.

**CHAPTER SECOND: REVIEW OF RELATED LITERATURE:**

In the first part researcher throws light on the importance and objectives of the review of related literature.

In this chapter a brief review of the related researches is taken. After taking this review researcher found that none of the study is directly related to development of Mathematics Experiment Notebook to Upper Primary Level students. Hence it can be claimed that the present research is original, novel and unique.
CHAPTER THIRD: PLAN AND PROCEDURE OF THE STUDY:

It deals with plan and procedure of the study.

The first section of this chapter deals with the preparatory phase of the experiment which contains development of Mathematics Experiment Notebook, determination of the period and the time schedule of the experiment. The researcher has explained the procedure he has used in the development of the Mathematics Experiment Notebook that he has constructed.

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 deals with the Post-Experimental Phase which was concerned with the information about the data producing tools employed in the study.

It also describes the experimental design, which suits to the study and sampling procedure. It also includes control of validity and variables. This chapter also covers analysis of the syllabus for selecting of the units and subunits, sampling procedure, and tools for the study, preparation of the study. It also describes the equivalence of the groups, orientation about teaching strategy, Steps of Conducting Lessons and conduct of the experiment with time schedule.

CHAPTER FOURTH: ANALYSIS AND INTERPRETATION OF DATA:

It deals with the analysis and interpretation of the data obtained through teaching with Mathematics Experiment Notebooks, performance of the students in terms of achievement tests. The means, SDs, t-value and ANOVA (F-values) were employed to the data to know the different effects of the treatment by calculation.

It is splitted into two parts-

A. Survey of present position of teaching Mathematics.

B. Data showing the effectiveness of the experiment.
The researcher has analyzed and interpreted each and every aspect of the obtained data related to the experimentation of the Mathematics Experiment Notebook (MEN) developed by him.

CHAPTER FIFTH: SUMMARY, CONCLUSION, RECOMMENDATIONS AND SUGGESTIONS:

The conclusions based on the analysis and interpretation of the data are given in this chapter. The followed suggestions and recommendations. This chapter consists of a brief chapter wise summary which is followed by major findings, implications, and recommendations for further studies. Findings were drawn on the basis of observations.

5.9 DISCUSSION OF RESULTS AND CONCLUSIONS:

For the first objective of the study, the researcher collected the data using questionnaire.

Following are the some of the results obtained from the responses of 25 teacher educators.

5.9.1 CONCLUSIONS BASED ON THE QUESTIONNAIRE:

From table 4.1 to 4.6 following were some of the conclusions obtained through careful analysis and interpretation of questionnaire.

Conclusions :

1. It is expected that Mathematics should be taught by those teachers having Mathematics as a special subject for their graduation. Majority (53.33 %) of the teachers were with Mathematics as a special subject for their graduation and teaching to upper primary classes.

2. In spite of the above expectation it is considered to be eligible if Mathematics is taught by the teachers with Mathematics group subjects i.e. Physics and Chemistry at their graduation. Thirty and 16.67 percent of the teachers respectively were teaching Mathematics to upper primary classes.
3. Hence it can be concluded that eligible teachers were teaching Mathematics to upper primary classes.

4. It was found that the number of available periods to teach Mathematics at upper primary level were sufficient.

5. Majority teachers were used the lecture method to teach Mathematics at upper primary level.

6. The teachers’ opinion that they wants to be teach Mathematics through experiments at upper primary level.

7. Almost all teachers observed that the text books of Mathematics at upper primary classes were related to the prescribed objectives.

(From the Table 4.1 to 4.6)

5.9.2 CONCLUSIONS BASED ON THE EXPERIENCED SCHOOL TEACHERS, RESEARCH EXPERTS AND STUDENTS OPINIONS ABOUT THE MEN:

From table 3.1 to 3.4 following are some of the conclusions obtained through careful analysis and interpretation based on the experienced school teachers, research experts and students opinions about the MEN.

Conclusion 1:

Developed MEN was inclusive and worthy for application to teach Mathematics for upper primary classes in the view of experienced school teachers.

Conclusion 2:

It was found that the MEN is up to the mark and fulfilled research expert’s expectations.

Conclusion 3:

It was concluded that the developed Mathematics Experiment Notebooks (MEN) was designed and constructed properly for teaching.
Conclusion 4:

It was also found that the Mathematics Experiment Notebook was up to the
mark and fulfilled student’s expectations.

(From the Table 3.1 to 3.4)

5.9.3 CONCLUSIONS BASED ON THE PRE-TEST:

Following are some of the conclusions obtained through careful analysis and
interpretation of pre-test.

Conclusion 1:

1. It was found that, the students of upper primary classes of both the schools from any
group did not differ in their performance in knowledge in the pretest.

2. Both the groups were equivalent in their achievement in knowledge w.r.t. means
before going for any further treatment in the experiment.

(From the table 4.7 to 4.9)

Conclusion 2:

1. It was found that, the students of upper primary classes of both the schools from any
group did not differ in their performance in comprehension in the pretest.

2. Both the groups were equivalent in their achievement in comprehension w.r.t. means
before going for any further treatment in the experiment.

(From the table 4.10 to 4.12)

Conclusion 3:

1. It was found that, the students of upper primary classes of both the schools from any
group did not differ in their performance in application in the pretest.

2. Both the groups were equivalent in their achievement in application w.r.t. means
before going for any further treatment in the experiment.

(From the table 4.13 to 4.15)
Conclusion 4:

1. It was found that, the students of upper primary classes of both the schools from any group did not differ in their performance in skill in the pretest.

2. Both the groups were equivalent in their achievement in skill w.r.t. means before going for any further treatment in the experiment.

   (From the table 4.16 to 4.18)

Conclusion 5:

1. It was found that, the students of upper primary classes of both the schools from any group did not differ in their variability about performance in knowledge in the pretest.

2. Both the groups were equivalent in their achievement in knowledge w.r.t. S.D.’s before going for any further treatment in the experiment.

   (From the table 4.19 to 4.21)

Conclusion 6:

1. It was found that, the students of upper primary classes of both the schools from any group did not differ in their variability about performance in comprehension in the pretest.

2. Both the groups were equivalent in their achievement in comprehension w.r.t. S.D.’s before going for any further treatment in the experiment.

   (From the table 4.22 to 4.24)

Conclusion 7:

1. It was found that, the students of upper primary classes of both the schools from any group did not differ in their variability about performance in application in the pretest.

2. Both the groups were equivalent in their achievement in application w.r.t. S.D.’s before going for any further treatment in the experiment.

   (From the table 4.25 to 4.27)
Conclusion 8:

1. It was found that, the students of upper primary classes of both the schools from any group did not differ in their variability about performance in skill in the pretest.

2. Both the groups were equivalent in their achievement in skill w.r.t. S.D.’s before going for any further treatment in the experiment.

(From the table 4.28 to 4.30)

5.9.4 CONCLUSIONS REGARDING EFFECTS OF MEN ON PUPILS PERFORMANCE IN THE POST-TEST:

Following are some of the conclusions obtained through careful analysis and interpretation regarding effects of MEN on pupil’s performance in the post-test.

Conclusion 1:

1. MEN created significant difference in the mean performance of knowledge of students in the experimental group as compared to control group from both the schools.

2. The developed Mathematics Experiment Notebook (MEN) helped the students from experimental group in performing better than the students from control group in acquiring knowledge.

(From the table 4.31 to 4.33)

Conclusion 2:

1. MEN created significant difference in the mean performance of comprehension of students in the experimental group as compared to control group from both the schools.

2. The developed Mathematics Experiment Notebook (MEN) helped the students from experimental group in performing better than the students from control group in acquiring comprehension.

(From the table 4.34 to 4.36)
**Conclusion 3:**

1. MEN created significant difference in the mean performance of application of students in the experimental group as compared to control group from both the schools.

2. The developed **Mathematics Experiment Notebook (MEN)** helped the students from experimental group in performing better than the students from control group in acquiring application.

   (From the table 4.37 to 4.39)

**Conclusion 4:**

1. MEN created significant difference in the mean performance of skill of students in the experimental group as compared to control group from both the schools.

2. The developed **Mathematics Experiment Notebook (MEN)** helped the students from experimental group in performing better than the students from control group in acquiring skill.

   (From the table 4.40 to 4.42)

3. The analysis and interpretation of the data obtained in post-testing indicated that the students from both schools of upper primary classes from control and experimental group were differing in their variability about the performance in post-test.

   (From the table 4.31 to 4.42)

**Conclusion 5:**

1. There is significant difference between the achievement score of the students from control and experimental group in post-test in knowledge, taught by using MEN and that with conventional method.

2. The developed **Mathematics Experiment Notebook (MEN)** helped the students from experimental group significantly achieving more than the students from control group in acquiring knowledge.

   (From the table 4.43 to 4.45)
Conclusion 6:
1. There is significant difference between the achievement score of the students from control and experimental group in post-test in comprehension, taught by using MEN and that with conventional method.
2. The developed **Mathematics Experiment Notebook (MEN)** helped the students from experimental group significantly achieving more than the students from control group in acquiring comprehension.
   (From the table 4.46 to 4.48)

Conclusion 7:
1. There is significant difference between the achievement score of the students from control and experimental group in post-test in application, taught by using MEN and that with conventional method.
2. The developed **Mathematics Experiment Notebook (MEN)** helped the students from experimental group significantly achieving more than the students from control group in acquiring application.
   (From the table 4.49 to 4.51)

Conclusion 8:
1. There is significant difference between the achievement score of the students from control and experimental group in post-test in skill, taught by using MEN and that with conventional method.
2. The developed **Mathematics Experiment Notebook (MEN)** helped the students from experimental group significantly to achieve more than the students from control group in acquiring skill.
   (From the table 4.52 to 4.54)
5.9.5 CONCLUSIONS REGARDING EFFECTS ON PUPILS PERFORMANCE IN THE PRE OVER POST-TEST:

Following are some of the conclusions obtained through careful analysis and interpretation regarding effects of MEN on pupil’s performance on pre over post-test in their respective groups.

Conclusion 1:

1. The students from the control group at pre-testing differed in their performance as compared with the performance in the post-test. It means that the Conventional Instructional System used in the control group favored the student’s knowledge in that group.

2. The students from the experimental group differ in their performance on pre over posttest scores in knowledge. The Developed Mathematics Experiment Notebooks used in experimental group favored the students in achieving better performance than control group in acquiring knowledge.

3. The student’s knowledge from the control group at pre-testing differs in their variability as compared with the variability in the post-test.

(From the table 4.55 to 4.57)

Conclusion 2:

1. The students from the control group at pre-testing differ in their performance as compared with the performance in the post-test. The Conventional Instructional System used in the control group favored the student’s comprehension in that group.

2. The students from the experimental group differ in their performance on pre over posttest scores in comprehension. The Developed Mathematics Experiment Notebooks used in experimental group favored the students in achieving better performance than control group in acquiring comprehension.

3. The student’s comprehension from the control group at pre-testing differs in their variability as compared with the variability in the post-test.

(From the table 4.58 to 4.60)
Conclusion 3:

1. The students from the control group at pre-testing differ in their performance as compared with the performance in the post-test. The Conventional Instructional System used in the control group favored the student’s application in that group.

2. The students from the experimental group differ in their performance on pre over posttest scores in application. The Developed Mathematics Experiment Notebooks used in experimental group favored the students in achieving better performance than control group in acquiring application.

3. The student’s application from the control group at pre-testing differs in their variability as compared with the variability in the post-test.

   (From the table 4.61 to 4.63)

Conclusion 4:

1. The students from the control group at pre-testing differ in their performance as compared with the performance in the post-test. The Conventional Instructional System used in the control group favored the student’s skill in that group.

2. The students from the experimental group differ in their performance on pre over posttest scores in skill. The Developed Mathematics Experiment Notebooks used in experimental group favored the students in achieving better performance than control group in acquiring skill.

3. The student’s skill from the control group at pre-testing differs in their variability as compared with the variability in the post-test.

   (From the table 4.64 to 4.66)

Conclusion 5:

The developed MEN were effective than conventional teaching method at all upper primary classes in both schools.

(From the table 4.67)

Conclusion 6:

The MEN were comparatively more effective for standard VIII and less effective for standard VII than other classes.

(From the table 4.68)
Conclusion 7:

1. The MEN were comparatively superior in comprehension and skill than the knowledge and application in both the schools.

2. The MEN were comparatively achieved lowest in knowledge than the comprehension, application and skill in both the groups of upper primary classes in both the schools.

(From the table 4.69)

5.10 IMPLICATIONS OF THE STUDY:

Mathematics is a science. As like other science subjects, Mathematics subject also provides activities. Hence it can be taught with experiments. But unfortunately this fact is neglected. The researcher thought over this and developed MEN for upper primary classes. With the help of teachers he taught some units according to the developed MEN and found progress in student’s achievement.

This study clearly shows that the Mathematics Experiment Notebooks were useful to teachers who were teaching Mathematics at upper primary classes. The present study has great significance because it is helpful to Board of studies to introduce the Mathematics Experiment Notebook (MEN).

The results of this study will be useful to develop a Mathematics laboratory (as per NCERT curriculum framework 2001).

Mathematics Experiment Notebook gives a new approach to upper primary school teachers. This approach embraces the pupils and learning in a more complete way than traditional method.

For researchers in the field of Education and Psychology, this study makes available the Mathematics Experiment Notebook for their research purposes and also to develop these types of Mathematics Experiment Notebook for other classes.
5.11 SOME RECOMMENDATIONS:

On the basis of the conclusions from the responses of the respondents, the researcher made the following recommendations.

A. Related to State Government:

1. The Mathematics curriculum should be added accordingly on the basis of Mathematics experiments.

2. The government should provide the training to the teachers about teaching methodology with the help of Mathematics Experiment Notebooks.

B. Related to Institutions:

1. Institute should provide all physical facilities like ‘Mathematics Laboratory’ to the students so that Mathematics would be taught by developed Mathematics Experiment Notebooks.

2. Institute should motivate the teachers to take active participation in developing the ‘Mathematics Laboratory’

C. Related to Head-masters:

1. The Mathematics would be taught in the Mathematics Laboratory.

2. The Head-masters should be inspires the teachers to apply the innovations in teaching.

D. Related to Teachers:

1. The teachers should use the developed Mathematics Experiment Notebooks in day-to-day teaching of Mathematics.

2. The Mathematics teacher’s organisations should conduct the group discussion about application of Mathematics Experiment Notebooks to teach this subject.
5.12 SUGGESTIONS FOR FURTHER RESEARCH:

While conducting the present research study, the researcher came across some areas that he feels explorations in them. For the benefit of the researchers in this field, the researcher has enumerated them here below -

1. The researcher feels that such type of studies can be conducted for secondary classes’ as well higher secondary level.

2. The researcher feels that the study can be done to compare the effect of the developed Mathematics Experiment Notebooks and Multimedia Instruction System on pupils’ achievement.

3. The study was conducted on government aided school with Marathi medium; the same study may be replicated in unaided English medium schools.

4. The study was conducted on a limited sample for a limited duration. A similar long term experimental study with large sample could be done.

5. A comparative Study can be conducted to see the effectiveness of teaching Mathematics by Computer Assisted Instruction and the developed Mathematics Experiment Notebooks on pupil’s achievement.

6. A comparative Study conducted on the effectiveness of teaching Mathematics through analytical method and the developed Mathematics Experiment Notebooks.

7. The Study conducted on the effectiveness of teaching Mathematics by constructivist method and the developed Mathematics Experiment Notebooks on pupil’s achievement.

8. A comparative Study conducted on the effectiveness of teaching Mathematics through inductive method and the developed Mathematics Experiment Notebooks on pupil’s achievement.

9. A comparative Study conducted on the effectiveness of teaching Mathematics through concept attainment model and the developed Mathematics Experiment Notebooks on pupil’s achievement.

10. The researcher feels that such type of studies can be conducted in other than Marathi medium for secondary classes’ as well higher secondary level.