CHAPTER - III
PIAN AND PROCEDURE

In the previous chapter, the researcher has presented the review of related literature. The present chapter deals with the procedure used by the researcher for conducting the research.

3.1 Research

The term ‘research’ consists of two words ‘Re’ and ‘Search’. ‘Re’ means again and again and ‘search’ means to find out something new. Thus, research is a process in which a person observes the phenomenon again and again, collects the data and draws some conclusions. Research is oriented towards the discovery of relationship that exists among different phenomena. It is based on the fundamental assumption that invariant relationships exist between certain antecedents and certain consequences, so that under a specific set of conditions certain consequents can be expected to follow the introduction of given antecedent.

Research in common parlance refers to a search for knowledge. One can also define research as a scientific and systematic search for pertinent information on a specific topic. In fact, research is an art of scientific investigation. Research is considered to be the more formal, systematic, intensive process of carrying on the scientific methods of analysis. It involves a more systematic structure of investigation, usually resulting in some sort of formal record of procedures and a report or conclusions.

Research is an academic activity and as such the term should be used in a technical sense. According to Clifford Woody (Kothari, C. R. 1989) research comprises defining and redefining problems, formulating hypothesis or suggested solutions, collecting, organizing and evaluating data, making deduction and reaching conclusions, and at last carefully testing the hypothesis and drawing conclusions.
The Advanced Learner’s Dictionary of Current English (2000) lays down the meaning of research as “a careful investigation or inquiry especially through search for new facts in any branch of knowledge”. Redman and Mory (1923) define research as a “systematized effort to gain new knowledge”. Some people consider research as a movement from the known to unknown. It is actually a voyage of discovery. It is an inquisitiveness of man for obtaining new knowledge.

Thus, research is directed toward the solution of a problem. It may be an attempt to answer question or to determine the relationship between two or more variables. It demands accurate observation and description. It involves gathering new data from primary sources or using existing data for a new purpose.

**Characteristics of Good Research**

Different Characteristics of Good Research has been put forth as follow

1) The purpose of research should be clearly defined and common concepts be used.

2) The research procedure used should be described in sufficient details to permit another researcher to repeat the research for further advancement, keeping the continuity of what has already been attained.

3) The procedural design of the research should be carefully planned to yield results that are as objective as possible.

4) The researcher should report with complete frankness, flaws in procedural design and estimate their efforts upon the findings.

5) The analysis of data should be sufficiently adequate to reveal its significance and the methods of analysis used should be appropriate. The validity and reliability of the data should be checked carefully.

6) Conclusion should be confined to those justified by the data of the research and limited to those for which the data provide an adequate basis.
7) Greater confidence in research is warranted if the researcher is experienced, has a good reputation in research and is a person of integrity.

3.2 Educational Research

Educational research refers to a systematic attempt to gain a better understanding of the educational process, generally with a view to improving its efficiency. It is an application of scientific method to the study of educational problems.

Travers M. W. (1978) states ‘Educational research refers to an activity directed towards the development of an organized body of scientific knowledge about the events with which educators are concerned, of central importance are the behavior patterns of pupils, and particularly those to be learned through the educational process.” According to George G. Muly (1970) ‘Educational Research is defined as the systematic and scholarly application of the scientific method, interpreted in its broader sense, to solution of educational problems. According to Whitney F. L. (1946) “Educational Research aims to make contribution towards the solution of the problems in the field of education by the scientific philosophical method”.

Thus, Educational Research is an activity which is directed towards the development of a science of behavior in educational situation. The ultimate aim of such a science is to provide knowledge that will permit the educators to achieve their goals by the most effective method.

Methods of Educational Research

All research involves the elements of observation, description and the analysis of what happens under certain circumstances. A rather simple four point analysis may be used to classify educational research. Particularly all studies fall under one, or a combination of these types.

1) Historical Research

The process involves investigating, recording, analyzing and interpreting the events of the past for the purpose of discovering generalizations that are
helpful in understanding the past and the present and, to a limited extent, in anticipating the future.

2) **Quantitative descriptive research**

   It uses quantitative methods of describing, and recording, analyzing and interpreting conditions that exist. It involves some type of comparison or contrast and attempts to discover relationship between existing non manipulated variables. Some form of statistical analysis is used to describe the result of the study.

3) **Qualitative descriptive research**

   It uses non quantitative methods to describe the situation. Qualitative descriptive research uses systematic procedures to discover non – quantifiable relationship between existing variables.

4) **Experimental Research**

   It describes what will be when certain variables are carefully controlled or manipulated.
3.3 Plan and Procedure of the Present Study

The plan and procedure of the present study can be revealed through the following chart.

Chart No. 1
Plan and Procedure of present study

Problem selection – Programme for Development of Scientific Attitude. Among school students – A study

- Operational Definitions of the Terms
- Review of Related Literature
- Objectives of the Study
- Assumption of the study
- Survey Method, Development of the programme, Experimental method
- Hypothesis
- Scope and Delimitations
- Research Sample
- Scientific Attitude Scale by Dr. G. S. Patil

<table>
<thead>
<tr>
<th>Tools</th>
<th>Situational test on Scientific Attitude prepared by the Researcher</th>
</tr>
</thead>
</table>

Data Collection

- Data Analysis

Deriving findings, conclusions and implications

Recommendations

Suggestions for the further studies
3.4 The Research Methods Adopted for the Present Study

The researcher adopted mixed method design for the present study. The methods used were as follows.
A] Survey – School Survey
B] Survey – Assessment Survey
C] Experimental Method.

The objective wise adoption of the research method is given below.

Table No.1

Objective wise Adoption of Research Methods

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Objectives</th>
<th>Method Adopted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>To measure the scientific attitude of 8&lt;sup&gt;th&lt;/sup&gt; and 9&lt;sup&gt;th&lt;/sup&gt; students</td>
<td>Survey Method: School Survey</td>
</tr>
<tr>
<td>2</td>
<td>To compare the levels of scientific attitude of boys and girls</td>
<td>Survey Method: School Survey</td>
</tr>
<tr>
<td>3</td>
<td>To compare the levels of scientific attitude of 8&lt;sup&gt;th&lt;/sup&gt; and 9&lt;sup&gt;th&lt;/sup&gt; students</td>
<td>Survey Method: School Survey</td>
</tr>
<tr>
<td>4</td>
<td>To find out the levels of different components of scientific attitude among the students.</td>
<td>Survey Method: School Survey</td>
</tr>
<tr>
<td>5</td>
<td>To prepare a scientific attitude development programme for 8&lt;sup&gt;th&lt;/sup&gt; and 9&lt;sup&gt;th&lt;/sup&gt; standard students</td>
<td>Survey Method: Assessment Survey</td>
</tr>
<tr>
<td>6</td>
<td>To study the effectiveness of the developed programme.</td>
<td>Experimental Method</td>
</tr>
<tr>
<td>7</td>
<td>To make recommendations to the concerned institutions and personnel with reference to the development of scientific attitude.</td>
<td></td>
</tr>
</tbody>
</table>
Thus, the research used survey method and experimental method to achieve the objectives of the study. Those methods have been described below.

### 3.5 Survey Method

Survey is an important method of research. It is concerned with the present and attempts to determine the status of the phenomena under investigation. It is further classified into four categories.

**The characteristics of the survey method**

The characteristics of the survey method are as given below

i. It gathers data from a relatively large number of cases at a particular time.

ii. It is concerned with the characteristics of a group and not of an individual.

iii. It determines present trends and solves current problems.

iv. It helps in fashioning many tools with which we do the research.

v. The survey is both qualitative and quantitative.

**Merits and limitations of the Survey Method**

**Merits**

i. Surveys are relatively inexpensive.

ii. They are useful in describing the characteristics of a large population. No other method of observation can provide this General capability.

iii. They can be administered from a location using mail, email or telephone; consequently very large samples are feasible, making the results statistically significant even when analyzing multiple variables.

iv. There is flexibility in the use of various tools and their administration.

**Limitations of the Survey Method**

i. Surveys are inflexible in that they require the initial study design (the tool and administration of the tool) to remain unchanged throughout the data collection.
ii. The researcher must ensure that a large number of the selected sample will reply.

iii. It may be hard for participants to recall information or to tell the truth about a controversial question.

iv. As opposed to direct observation, survey research (excluding some interview approaches) can seldom deal with “context”.

3.6 Survey in the Present Study

A. School Survey

School Survey is usually an assessment and evaluation study. All school surveys focus attention on unfulfilled needs of school system. School Survey is undertaken in order to determine the service that a school can render to community. The purpose of school survey is to get detail information to be used as a basis for judging the effectiveness of the instructional facilities, curriculum, teaching and supervisory personnel and financial resources in the terms of best practices and standards in education.

In the present study the researcher has conducted a school survey to achieve first four objectives. Firstly the researcher studied the present level of scientific attitude of 644 school students, 322 8th standard students and 322 9th standard students and then the levels of scientific attitude of boys and girls and of 8th standard students and 9th standard students was compared. Also the levels of components of Scientific Attitude were identified.

B) Assessment Survey

Assessment is a fact finding activity, describing conditions that exit at a particular time. No hypothesis is proposed or tested, no variable relationships are examined.

In the present study to achieve the fifth objective which was to develop a programme for developing Scientific Attitude, the assessment survey was conducted. The programme was developed under the guidance of the experts in the field. The process of developing the programme has been described as under
3.7 Development of Scientific Attitude Programme

Programmes are developed aiming to achieve specific educational objectives with least time and resources. They have to assure the quality, practicability, effectiveness regarding their objectives. Enrichment of programme with these attributes is possible through systematic development of programme.

The process of development of programme has many dimensions, approaches and phases. There are various popular models for programme development.

Among these models Gaya’s Instructional System Design was selected for the development of programme in this study. The reasons why this model was prepared are as follows

1. It has great relevance with objectives of present study.
2. It has evaluation and feedback mechanism.
3. It has cyclic system which is useful for quality improvement of programme.

The General Structure of this model is shown below


'Define' phase is abstract and is more intellectual activity that brings essential clarity required for further steps. It defines the objectives, expected attributes, components, parts, sequences etc.
The phase ‘Develop’ belongs to processing and organization of content and components in well defined frame of objectives and attributes. It is the central phase connecting to all other phases.

‘Evaluate’ phase of establishing the standards of programme, it is the judgment of degree of validity, relevance of programme with the objectives, adequacy, accuracy, practicability etc. This phase provides feedback for revision.

‘Revise’ is phase of assimilation of feedback emerged through ‘Evaluate’ phase. It produces the way to strengthen the programme. The standards of programme like validity, relevance, adequacy etc. are strengthened by editing the content, components, their sequences and organization.

Use of Gaya’s Model for the Present Study

The procedure of developing the Scientific Attitude Programme in this study is described in the following paragraphs.

Phase I-Define

After the review of related literature and discussion with the experts in the field researcher was able to define the Scientific Attitude Development Programme for school students. At this phase objective and activities to be included in the programme were identified as follows.

A) Objectives of the programme

There are different components of scientific attitude. Out of those components nine such components were identified for the programme, the inculcation and evaluation of which is practically possible in the normal classroom environment and accordingly the objectives of the programme were defined as follows:

To develop among the students

1. Critical Thinking Ability.
2. Open Mindedness.
3. Readiness to Change the Decision.
5. Aversion to Superstitions.
8. Seeking to adopt different planed procedure in solving the problem.
9. Respect of scientific experience.

B) Activities and their content

Thirteen activities were identified for the inclusion in the programme. The content in which the scientific attitude was to be inculcated was searched through the 8th and 9th standard textbooks of Science, Mathematics Geography, History and Languages. This has been given in the following table.

Table No.2
Activities of the programme and their content

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Activity</th>
<th>Content</th>
<th>Text Book Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Scientific Method For Problem Solving</td>
<td>1. Dowry System 2. Problems in daily life</td>
<td>8th standard Marathi Textbook-Prose</td>
</tr>
<tr>
<td>3</td>
<td>Magic Square</td>
<td>Basic mathematical operations –addition, multiplication, subtraction and division</td>
<td>Mathematics</td>
</tr>
<tr>
<td>4</td>
<td>Project Method</td>
<td>Management of waste</td>
<td>Science-Environmental Education</td>
</tr>
<tr>
<td>6</td>
<td>Inductive Thinking Model</td>
<td>1. Square 2. Rectangle</td>
<td>Geometry</td>
</tr>
</tbody>
</table>
| 7  | Heuristic Method | 1. Density  
2. Measuring Thickness of a wire  
3. Expansion and contraction of Air  
4. Relationship between height and Potential energy  
5. Separate elements from mixture  
6. Counting Heart Beats  
7. Measuring Depth and pressure of water | Science |
|----|------------------|------------------------------------------------|
| 8  | Reading books on Scientific information | 1. Antaral (अंतराल)  
2. Computer (संगणक)  
3. Vidyanachacha Kalptaru (विद्यानाचा कल्पतरु)  
4. Kutuhal Vidyanachache (कुतुहल विद्यानाचे) | 1. Science and Geography-Earth, Galaxy, Use of Telescope, Importance of science  
2. Information Technology |
| 9  | Scientific Toys | 1. Life cycle of a Butterfly  
2. Pythagoras Theorem  
3. Basic Astronomy  
4. Use of sextant  
5. Rainbow color  
6. Air pressure  
7. Area of Triangle | 1. Science  
2. Geometry |
| 10 | Jigsaw | The National Uprising 1857 | History |
| 11 | Scientific Puzzles | 1. Atom  
2. Cell as a Fundamental unit of Life  
3. Quality Food and Quality Life  
4. Disease  
5. Carbon and carbon compounds  
2. Geometry  
3. Biology |
|    |                  |                                                      |
C) Outline of the Programme

The outline of the Programme was defined after some revisions. The finalized outline was as follows

i. No. of Activities - 13
ii. Total hours - 44 clock hours (88 class periods)
iv. No disturbance in the school timetable

Phase II – Develop

According to the objectives and activities which were defined in the phase I, the programme was developed.

The theoretical information regarding each activity was collected, so that effective planning was possible.

Many rough drafts were prepared and edited as per the need and finally the first draft to be evaluated by the expert was prepared in the following format

- Objectives of the activities
- Content to be delivered
- Day, Date Time and No. of periods
- Title and steps of the activities
- Teacher activity
- Student activity

Phase III – Evaluate

The programme was evaluated by the five experts in the field

i. Scientific Officers (Homi Bhaba Center For Science Education) - 03.
The experts suggested some changes as given in the following table

### Table No. 3

**Expert’s Suggestions on the First Draft of the Programme**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of the Activity</th>
<th>Expert’s Suggestion on given activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Presentation of Scientific stories</td>
<td>i) Mention the objectives.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ii) Explain student activities.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>iii) Mention the stories (title and main point)</td>
</tr>
<tr>
<td>2</td>
<td>Scientific Method of Problem Solving</td>
<td>i) Give problems related to day-to-day life.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ii) Give problems related to the syllabus.</td>
</tr>
<tr>
<td>3</td>
<td>Magic Square</td>
<td>No change</td>
</tr>
<tr>
<td>4</td>
<td>Project Method</td>
<td>i) Change the Title of the project.</td>
</tr>
<tr>
<td>5</td>
<td>Concept Mapping</td>
<td>i) Change the objectives.</td>
</tr>
<tr>
<td>6</td>
<td>Inductive Thinking</td>
<td>No change</td>
</tr>
<tr>
<td>7</td>
<td>Heuristic Method</td>
<td>i) Provide cards mentioning the steps of the Experiments.</td>
</tr>
<tr>
<td>8</td>
<td>Reading on Scientific Books</td>
<td>No change</td>
</tr>
<tr>
<td>9</td>
<td>Preparation of Scientific Toys</td>
<td>No change</td>
</tr>
<tr>
<td>10</td>
<td>Jigsaw</td>
<td>Change the objectives.</td>
</tr>
<tr>
<td>11</td>
<td>Scientific Puzzles</td>
<td>No change</td>
</tr>
<tr>
<td>12</td>
<td>Lecture on Superstitions</td>
<td>No change</td>
</tr>
<tr>
<td>13</td>
<td>Movie on Superstitions</td>
<td>No change</td>
</tr>
</tbody>
</table>

**Phase IV – Revise**

According to the suggestions given by the experts the programme was revised.
Phase V – Evaluate and Develop

The Programme was again evaluated by the same experts. Some minor changes were suggested by the experts. Accordingly the change was made and programme was finalized. This programme has been given in the Appendices.

3.8 Experimental Method

Experimental Method is a more scientific method of research. The purpose of experimentation is to desire verified functional relationship among phenomena under controlled conditions. It is a matter of varying the independent variables in order to study the effect of such variation on dependent variable. An experiment involves the comparison of effect on the particular treatment with that of a different treatment or no treatment.

Characteristics of Experimental Method

i) It emphasizes objectivity and accuracy in the collection of the data and treatment part of it.

ii) It emphasizes control of conditions and the experimentation of certain variables in controlled conditions.

iii) It sets out the relationship between the phenomenon and this relationship is more or less of the causal type.

iv) It uses standardized tool for experimentation and make the evidences very much objective.

v) The sample is selected with great precaution and every care is taken to safeguard extraneous factors.

vi) It leads to the testing of a specific hypothesis and experimental evidences so called as to reject or retain the hypothesis.

vii) The laws, postulates and theories of education are developed mostly through experimental methods.
**Steps of Experimental Method**

i) Selecting and Delimiting the problem  
ii) Reviewing the literature  
iii) Preparing experimental design  
iv) Defining the population  
v) Carrying out the experiment  
vi) Measuring the outcomes  
 vii) Analyzing and interpreting the outcomes  
viii) Drawing up the conclusions  
ix) Reporting the results

**3.9 Experimental Designs**

Experimental design is the blueprint of the process that enables the researcher to test hypotheses by reaching valid conclusions about relationships between independent and dependent variables. Selection of a particular design is based on the purposes of the experiment, the type of variables to be manipulated, and the conditions or limiting factors under which it is conducted. The design deals with such practical problems as how subjects are to be assigned to experimental and control groups, the way variables are to be manipulated and controlled, the way extraneous variables are to be controlled, how observations are to be made, and the type of statistical analysis to be employed in interpreting data relationships.

**Types of Experimental Designs**

There are three categories of experimental design. Under each category there are different types of designs.

1. **Pre-Experimental Designs**

   It is least effective, for it provides either no control group or no way of equating the groups that are used.

   The types of this design are as under.
i) The One-Shot case study

O X O

In this design carefully studied results of a treatment are compared with a general expectation of what would have happened if the treatment had not been applied. This design provides the weakest basis for generalization.

ii) The One-Group Pretest-Post-test Design

O1 X O2

O1 = pretest O2 = Post-test

This design provides some improvement over the first, for the effects of the treatment are judged by the difference between pretest and the post-test scores. However, no comparison with a control group is provided.

iii) The Static – Group Comparison Design

X O

C O

This design compares the status of a group that has received an experimental treatment with one that has not. There is no provision for establishing the equivalence of the experimental and control groups, a very serious limitation.

2. True Experimental Designs

In a true experimental design the equivalence of the experimental and control groups is provided by random assignment of subjects to experimental and control treatments. The types of this design are as below

i) The post-test only equivalent-Group Design

R X O1

R C O2

This design is one of the most effective in minimizing the threats to experimental validity.
ii) The Pretest – Post-test Equivalent-Group Design

R O1 X O2  O1O3 = Pretests
R O3 C O4  O2O4 = Posttest

X gain = O2 – O1
C gain = O4 – O3

This design is similar to above described design, except that pretests are administered before the application of the experimental and control treatments and posttests at the end of the treatment period.

iii) The Soloman four-Group Design

R O1 X O2
R O3 C O4
R X O5
R C O6

The design is a combination of the two two-group designs above described the posttest only and pretest-posttest. The Soloman Four-Group Design permits the evaluation of the effects of testing, history and maturation.

3. Quasi Experimental Designs

Quasi Experimental Designs provide control of when and to whom the measurement is applied, but because random assignment to experimental and control treatments have not been applied, the equivalence of the groups is not assured. The types of this design are as below:

i) The Pretest – Posttest Nonequivalent-Group Design

O1 X O2  O1O3 = pretests
O3 C O4  O2O4 = posttests

This design is often used in classroom experiments when experimental and control groups are such naturally assembled groups as intact classes, which may be similar.
ii) The Time-Series Design

\[
\begin{array}{cccccccc}
O1 & O2 & O3 & O4 & X & O5 & O6 & O7 & O8 \\
\end{array}
\]

In the time-series experimental design, a measured change or gain from observation 4 (O4) to observation 5 (O5) would indicate that the treatment had an effect.

iii) The Equivalent Time – Samples Design

\[
\begin{array}{cccccccc}
O1 & X & O2 & C & O3 & X1 & O4 & C & O5 \\
\end{array}
\]

Instead of having equivalent samples of persons, it may be necessary to use one group as the experimental and control group. In this design the experimental condition X1 is present between some observation and not (C) between others.

iv) The Equivalent Materials Pretest, Post-test Design

\[
\begin{array}{cccccccc}
O1 & XMA & O2 & O3 & XMB & O4 \\
\end{array}
\]

XMA = teaching method AXMB = teaching method B

O1 and O3 are pretests O2 and O4 are posttests.

3.10 Experimental Design used in the Present Study.

In the present study the Post-test only equivalent group design was used.

The Post-test only equivalent group design

\[
\begin{array}{cccc}
R & X & O1 \\
R & C & O2 \\
\end{array}
\]

This design is one of the most effective in minimizing the threats to experimental validity. It differs from the static group comparison design in that experimental and control groups are equated by random assignment.

At the conclusion of the experimental period the difference between the mean test scores of the experimental and control group is subjected to a test of statistical significance usually a t test or an analysis of variance.
Chart No.2
The Post-test Only Equivalent Group Design

Shri Jaysing Mohite Patil Vidyalaya, Akluj (Dist-Solapur)

Total students in 8th and 9th standard

Random Sampling → 80 students (40 8th standard and 40 9th standard)

Pretesting (Scientific Attitude Scale by Dr. G.S.Patil)

Equivalent Groups

40 students

<table>
<thead>
<tr>
<th>8th standard</th>
<th>9th standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>10</td>
</tr>
<tr>
<td>Girls</td>
<td>10</td>
</tr>
</tbody>
</table>

40 students

<table>
<thead>
<tr>
<th>8th standard</th>
<th>9th standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>10</td>
</tr>
<tr>
<td>Girls</td>
<td>10</td>
</tr>
</tbody>
</table>

Experimental Treatment

No Treatment

Post testing

i. Scientific Attitude Scale (Prepared by Dr.G.S.Patil)

ii. Situation Test on Scientific Attitude (Prepared by the Researcher)
As given above Shri Jaysingh Mohite Patil Vidyalaya was selected for conducting the experiment. From this high school 80 students, 40 from 8\textsuperscript{th} standard and 40 from 9\textsuperscript{th} standard, were randomly selected and a pretest was given to them. Based on the pretest scores two equivalent groups were prepared.

Scientific Attitude Development Programme was conducted on experimental group. Control group was a no treatment group. Post tests were given both the groups and results analyzed.

3.11 Variables

A concept which can take on different values is called a variable. Variables are the conditions or the characteristics that the experimenter manipulates, controls or observes.

Types of variables
There are five main types of variables. As shown below.

Chart No. 3
Types of Variables

- Dependent Variables
- Independent Variables
- Moderate Variables
- Control Variables
- Confounding Variables
- Treatment Variables
- Organism or Attribute Variables
- Intervening Variables
- Extraneous Variables
1) **Dependent Variables**

   It is that factor which is observed and measured to determine the effect of the independent variables.

2) **Independent Variable**

   It is the factor which is measured, manipulated or selected by the experimenter to determine its relationship to an observed phenomenon.

3) **Moderate Variables**

   It is secondary independent variable selected to determine whether it affects the relationship between the primary independent variable and the dependent variable.

4) **Control Variables:**

   All the variables in a situation cannot be studied at the same time. Some must be neutralized to guarantee that they will not have a differential or moderating effect on the relationship between the independent and dependent variables. The variables whose effects are neutralized or controlled are known as control variables.

5) **Confounding Variables**

   Confounding Variables are those aspects of a study or sample that might influence the dependent variable (outcome measure) and whose effect may be confused with the effects of the independent variables. Confounding Variables are of two types

   i) **Intervening Variables**

   ii) **Extraneous Variables**

i) **Intervening Variables**

   Intervening Variables are certain variables, which cannot be controlled or measured directly and which may have an impact or important effect upon the outcome.
ii) **Extraneous Variables**

Extraneous Variables are those uncontrolled variables (i.e. variables not manipulated by the experimenter) that may have a significant influence upon the result of the study.

### 3.12 Variables in the Present Study

The variables involved in the present study are as follows

1) **Dependent Variables**

   The dependent variable in the present study was scientific attitude of the students measured with the help of Scientific Attitude Scale and Situational test on Scientific Attitude.

2) **Independent Variable**

   In the present study, independent variable was the Scientific Attitude Development Programme

3) **Control Variables**

   In this experiment age, sex and classroom conditions were controlled. Equal treatment was given to the whole group.

4) **Extraneous Variables**

   In these experiments the socio-economic condition of the students was extraneous variable because it was not controlled in the experiments.

### 3.13 Sampling

**Population**

The population or universe means the entire mass of observations, which is the parent group from which a sample is to be drawn. The sample observations provide only an estimate of the population characteristics.

**Sample**

According to Oxford Dictionary (2006) “Sample is a number of people or things taken from a large group and used in test to provide information about the group”.

Sample is a small proportion of a population selected for observation and analysis. By observing the characteristics of the sample one can make certain inference about the characteristics of the population from which it is drawn. Sample is needed to measure the characteristics of a large population. Sampling makes it possible to draw valid inference or generalization on the basis of careful observation of variables within a small proportion of the population.

**Characteristics of a Good Sample**

1) It is a true representative of the population.
2) It is comprehensive in nature.
3) It is free from bias.
4) It is an objective one.
5) It maintains accuracy.
6) A good sample is economical.
7) The subjects are easily approachable.
8) The size of sample is such that it gives an accurate result.
9) It makes the research work more feasible.
10) It has the practicability for research situation.

**Types of Sampling Design**

The following table shows the types of Sampling Design

**Table No. 4**

<table>
<thead>
<tr>
<th>Types of Sampling Design</th>
<th>Element selection Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Representation basis</td>
<td>Unrestricted Sampling</td>
</tr>
<tr>
<td>Probability Sampling</td>
<td>Simple Random Sampling</td>
</tr>
<tr>
<td>Non Probability Sampling</td>
<td>Haphazard Sampling</td>
</tr>
<tr>
<td>Restricted Sampling</td>
<td>Complex Random Sampling</td>
</tr>
<tr>
<td>(such as cluster sampling, systematic sampling, stratified sampling)</td>
<td>Purposive Sampling</td>
</tr>
<tr>
<td>(such as auto sampling, judgment sampling)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Dr. C.R. Kothari (1991), Research Methodology, Methods and Techniques, p.72
3.14 **Sampling in the Present Study**

In the Present study the researcher selected sample in two stages. They are as follows

A) **Sampling For the Survey**

**Chart No. 4**

**Sampling for the Survey**

Marathi Medium Co-education Schools in Malshiras Taluka (Dist.-Solapur, Maharashtra)

- Aided schools - 62
- Unaided schools - 05
- Selection of 10% schools by lottery method
- Selection of 10% school by lottery method
- 06 schools
- 01 school
- 07 schools
- From 8th standard-23 boys and 23 girls
- Each School
- 9th standard-23 boys and 23 girls
- 7 schools x 92 students = 644 students

In Malshiras Taluka of district Solapur (Maharashtra) there are 67 Marathi medium co-education schools. Out of those schools 62 schools are aided and five schools are unaided. Out of those schools 10% i.e. six aided schools and one unaided school was selected by using simple random sampling method (lottery method).
2) Selection of the students
From seven schools 644 students were selected as follows.
7 schools X 92 students (per school)
8\textsuperscript{th} Std. = 46 students (23 boys and 23 girls per school)
9\textsuperscript{th} Std. = 46 students (23 boys and 23 girls per school)
= 644 students (322 boys and 322 girls)

B) Sampling For the Experimental work

\textbf{Chart No. 5}

\textbf{Sampling for Experimental Work}

Marathi medium co-education schools in Malshiras Taluka (Dist.-Solapur, Maharashtra)

Purposive Sampling

Shri Jaysingh Mohite-Patil Vidyalaya, Sangramnagar (Akluj)

80 students (40 from 8\textsuperscript{th} standard and 40 from 9\textsuperscript{th} standard)

Pretesting-Two equivalent Groups

<table>
<thead>
<tr>
<th></th>
<th>Experimental Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>10 10</td>
<td>10 10</td>
</tr>
<tr>
<td>Girls</td>
<td>10 10</td>
<td>10 10</td>
</tr>
</tbody>
</table>

\textbf{Boys} 8\textsuperscript{th} standard 9\textsuperscript{th} standard
\textbf{Girls} 8\textsuperscript{th} standard 9\textsuperscript{th} standard
As shown above from 62 aided Marathi medium schools Shri. Jaysinh Mohite-Patil Vidyalaya was purposively selected for the experiment, because the Headmaster was ready to provide all the facilities required for the experiment. From this school 80 students were randomly selected- 40 from 8th standard and 40 from 9th standard. After the pretesting two equivalent groups of 40 each were prepared. One group was experimental group and other was control group.

3.15 Tools of Data Collection

There are several ways of data collection, which differ considerably in context of the tools, methods, money, time and other resources. The data can be collected through observation, interviews, questionnaires, schedules, etc.

In the present study the researcher collected the data through

A) Situational Test on Scientific Attitude

B) Scientific Attitude Scale.

C) Rating Scale

A) Situational Test on Scientific Attitude

Situational Test is a kind of psychological test. Although the term “Situational test” first came into prominence during World War II, tests of this type had been developed before that time also. Essentially a situational test is one that closely resembles or simulates a “real life” criterion situation. In this respect, such tests are similar to the work sample trade tests.

In situational test the criterion behavior that is sampled is more varied and complex. Moreover, focus is centered, not on aptitude or achievement but on emotional, social, attitudinal and other personality traits.

The student has to respond to the criterion situation though imagination. He has to think how he or she will behave in a particular situation.

Situational Test in the Present Study

In the present study, researcher prepared a situational test on scientific attitude related to the nine components. viz, critical thinking, open mindedness,
to be ready to change the decision, to be curious, not to believe in superstitions, to suspend the judgment until the suitable support is obtained, to be intellectually honest, seeking to adopt different planned procedures in solving the problem, to have respect for scientific experiments.

Development of Situational Test on Scientific Attitude (STSA)

The Situational Test on Scientific Attitude was developed by the researcher using following steps

Step I: Preparation of the Test

A) Preparation of Blue Print
B) Preparation of items

Steps II: Experts Suggestions

Steps III: Preparing instructions and fixing the time limit

Steps IV: Finalization of the Test

A) Item Analysis
   i) Determining the Item difficulty
   ii) Determining the Discriminating power

B) Establishing Validity and Reliability
   i) Validity
   ii) Reliability

Step I: Preparation of Test

A) Preparation of a Blue Print

The Blue Print of the test was prepared as follows
Table No.5
Blue Print of the Situational Test

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Components of Scientific Attitude</th>
<th>No. of Items</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Critical Thinking Ability</td>
<td>05</td>
<td>05</td>
</tr>
<tr>
<td>2</td>
<td>Open Mindedness</td>
<td>05</td>
<td>05</td>
</tr>
<tr>
<td>3</td>
<td>To be ready to change the decision</td>
<td>05</td>
<td>05</td>
</tr>
<tr>
<td>4</td>
<td>To be curious</td>
<td>05</td>
<td>05</td>
</tr>
<tr>
<td>5</td>
<td>Not to believe in superstitions</td>
<td>05</td>
<td>05</td>
</tr>
<tr>
<td>6</td>
<td>To suspend the judgment until the suitable support is obtained</td>
<td>05</td>
<td>05</td>
</tr>
<tr>
<td>7</td>
<td>To be intellectual honesty</td>
<td>05</td>
<td>05</td>
</tr>
<tr>
<td>8</td>
<td>Seeking to adopt different planned procedures in solving the problem</td>
<td>05</td>
<td>05</td>
</tr>
<tr>
<td>9</td>
<td>To have respect for scientific experiments</td>
<td>05</td>
<td>05</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>45</strong></td>
<td><strong>45</strong></td>
</tr>
</tbody>
</table>

All the questions are multiple choice questions

**B) Preparation of items**

Initially about 90 items were prepared.

**Step II: Discussion with the Experts**

The test comprising 90 items was examined by five experts in the field. They suggested some changes in the items and their alternatives.

**Steps III: Preparing instructions and fixing the time limit**

The instructions for solving the test were prepared and time limit of 30 minutes was fixed.

**Steps IV: Finalization of the Test**

The test was now given to 100 students, 50 8th standard and 50 9th standard students studying in Krishannanand Vidyalaya, Patil Vasti (Akluj), so that item
analysis could be done, similarly reliability of the test was also established with the help of this sample.

A) Item Analysis

During item analysis item difficulty and discriminating power of item was determined.

i. Determining the Item Difficulty

For most testing purposes, the difficulty of an item is defined in terms of the percentage of persons who answer it correctly. The easier the item, the larger will be the percentage. A word that is correctly defined by 70 percent of the standardization sample \(p=70\) is regarded as easier than one that is correctly defined by only 15 percent \(p=15\). It is customary to arrange items in order of difficulty, so that being with relatively easy items and proceed to items of increasing difficulty. This arrangement gives the individual confidence in approaching the test and also reduces the likelihood of his wasting much time on item beyond his ability to the neglect of easier items he can correctly complete.

In the process of test construction, a major for measuring item difficulty is to choose items of suitable difficulty level.

The formula for calculating Difficulty Value of item is as follows

\[
\text{Difficulty Value} = \frac{\text{Number of Students attempting item correctly} \times 100}{\text{Total Number of Students}}
\]

The item having difficulty value between 0.25 to 0.85 was selected. The item difficulty of all the items is given in the appendices

ii. Determining the Discrimination Index

The discriminating power of a item refers to the degree to which it discriminates between the bright and the dull pupils in a group. Following Procedure was adopted for calculating the discrimination power.

i) The test papers were arranged in order of size of the test scores.

ii) Then twenty seven percent papers at the top were counted off. Also, the bottom twenty seven percent papers were counted and middle papers
were kept outside as they were useful simply to make the two end groups.

iii) For calculating the discrimination power following formula was used.

\[
\text{Discrimination power} = \frac{(U - L)}{\frac{1}{2} N}
\]

Where,
- \( U \) = Number of students in upper group who wrote correct answer
- \( L \) = Number of students in lower group who wrote correct answer
- \( N \) = Total Number of students in upper and lower group.

The Discrimination power of each item is given in appendices.

**B) Validity and Reliability of the Test**

Validity is the degree with which a test measure what it claims to measure. If the test is not valid, then result cannot be accurately interpreted and applied. According to Thorndike and Hagen (1969), “A measurement procedure is valid in so far as it co-relation with some measurement of success in job for which it is being used as a predictor.” Hence correlation with some measurement of success is important.

**Types of Validity**

i) Face validity

ii) Content validity

iii) Criterion validity

iv) Concurrent validity

v) Predictive validity

vi) Construct validity

Two types of validity were established for this situational test.

**i) Face validity**

A subjective form of validity measure, which associates the variable of interest with the proposed study variable, by relying heavily on logic and common sense. The face validity was established with the help of five same experts who evaluated the Scientific Attitude Development Programme.
ii) Content validity

It is a less subjective form of validity measure than face validity, although it does extend from face validity, which relies on an assessment of whether the proposed measure incorporates all content of particular construct. The content validity was established by defining the nine components of scientific attitude and preparing separate items for each component and then evaluation by the experts.

Reliability

Reliability is the degree of consistency that the instrument or procedure demonstrates, whatever it is measuring, it does so consistently. Reliability is necessary but not sufficient condition for validity. That is, a test must be reliable for it to be valid, but a test can be reliable and still not be valid.

Methods of establishing Reliability

i. Test-Retest Reliability

ii. Alternate-Form Reliability

iii. Split-half Reliability

iv. Kuder-Richardson Reliability

v. Scorer Reliability

The Reliability of the Situational Test on Scientific Attitude was established by using Test-Retest method. The gap between the Testing and retesting was of 10 days. The reliability of the test was found to be 0.84. (The sample was same as was used for item analysis).

B) Scientific Attitude Scale (prepared by Dr. G. S. Patil)

The Scientific Attitude Scale prepared by Dr. G. S. Patil (Assistant Professor Department of Shivaji University, Kolhapur, 2007) was used in this study with her permission. This scientific attitude scale contains 45 statements related to the nine components, five statements for each component questions. This scale is related to nine factors which are selected in this study viz Critical Thinking, Open mindedness, To be ready to change the decision, To be curious, Not to believe in superstitions, To suspend the judgment until the
suitable support is obtained, To be intellectually honest, Seeking to adopt different planned procedures in solving the problem, To have respect for scientific experiment.

The Reliability of this Scientific Attitude scale was established by the researcher by using Test-Retest method. The gap between the Testing and retesting was of 15 days. The reliability of the test was found to be 0.93 which indicates that this scientific attitude scale is much reliable. (The sample was same as used for item analysis.)

C) Rating Scale

The Rating Scale involves qualitative description of a limited numbers of aspects of a thing or traits of a person. The classification may be set up in three, five or seven categories. In such terms as-poor, below average, average, good and excellent. The descriptions enable the judge to identify the characteristics to be rated.

In the present study the researcher used a three point scale Average-Good–Excellent, for evaluating the Scientific Attitude Development Programme and Situational Test on Scientific Attitude. Along with the rating scale the judges were requested to give suggestions for modifications.

The suggestions given by the experts for modification in the Scientific Attitude Development Programme and Situational Test on Scientific Attitude have been given under the heading Development of Scientific Attitude Development Programme.

Thus the procedure of the study has been given in the present chapter. The next chapter deals with the analysis of data and interpretation.