CHAPTER – III
PLANNING AND PROCEDURE

3.1 INTRODUCTION
3.2 METHOD OF RESEARCH
3.3 TOOLS USED IN THE STUDY
  3.3.1 ATTITUDE SCALE
  3.3.2 SCORING KEY
  3.3.3 SCALE NORMS
3.4 SELECTION OF THE SAMPLE
  3.4.1 SAMPLING TECHNIQUE
  3.4.2 SAMPLE SIZE
3.5 DATA COLLECTION
3.6 DATA ANALYSIS
CHAPTER – III
PLANNING AND PROCEDURE

3.1 INTRODUCTION

The next step in the process of research after reviewing the related literature is the planning and procedure of the study. The planning helps the investigator in the preparation of the research design on the problem under study. The planning is the fundamental and essential step of any research work before the implementation.

It is obviously true that the careful and thoughtful planning of work helps to save time, energy and economy. No work can be successfully finished without it being planned. So planning is very important in research work. A research plan serves a number of different purposes. Traver states,

- The research plan helps the investigator to organize his idea in a form where it will be possible for him to look for flow and inadequacy.
- The research plan provides an inventory of what has to be done and what materials have to be collected as a preliminary step in the undertaking of the study.
- The research plan is document that can be given to others for comment and criticism.

Any scientific research requires a systematic process which should be objective and involves in collecting data from the selected sample, analyzing and interpreting data to arrive at the conclusions. Any kind of research requires this process. A scientific research process has systematic stages to follow. The stages of the process are interdependent so change in one stage affects the other stages. The stages involved in the process of research study are generally eight, identification of the problem, review of related literature, clarifying the problem, defining terms and concepts, defining population, selection or construction of the tool, data collection and data analysis.

Research studies are distinguished on the basis of their purposes and approaches and that is what may be technically called difference in methods.

3.2 METHOD OF RESEARCH

Research is a scientific process which follows systematic and orderly procedure. From problem discovery to writing and publishing report of the study, the investigator has to pass through several stages of the procedure. Problem discovery and defining the problem is the first stage of the research procedure which includes selection of the
exploratory research technique and formulation of research objectives. The second stage of the research procedure is research design which includes selection of basic research method, e.g. experiment, survey, observation, secondary data study or historical study. The third stage of the research procedure is sampling selecting exploratory research technique which can be either probability or non probability sampling technique. The fourth stage is data collection which is a field work. After collecting data, the fifth stage is data processing and data analysis which involves editing and coding data and data processing. The last stage is conclusions and report which involves interpretation of findings and writing research report. The stages of the research procedure are graphically presented in Figure-3.1.
Figure-3.1
Research Procedure

1. Problem Discovery
2. Selection of Exploratory Research Technique
3. Problem Definition (Statement of Research Objectives)
4. Selection of Basic Research Method
5. Selection of Sampling Technique
6. Collection of Data (Field Work)
7. Editing and Coding Data
8. Data Processing
9. Interpretation of Findings
10. Report
For the completion of research, the selection of methods of research has its own importance. Judicial choice of method is the basis of success. Research studies adopting different methods, however, as a rule, differ significantly in their procedures. When the problem has been selected, an investigator has to study its characteristics and nature with great care. Then he has to clarify understanding of basic principles of research methodology and decide upon which type of research method his study falls so that it will be helpful in making the analysis of research process more comprehensible.

The investigator can follow some strategy for the selection of research methodology. If the research problem is based on direct access to the facts, the investigator should adopt empirical research methodology. In the empirical research study, if there is experimental research design, the investigator should control the variables and all physical environments to conduct a laboratory experiment.

If the research problem is not based on the direct access to the facts, the investigator should inquire about the nature of the information required for his study. If the information comes from the people, the research methodology will be classified as an opinion strategy which can be either individual or group strategy; but if the information comes from some data bank, the research methodology will be classified as an archival strategy. The archival documents are of primary and secondary sources but if the archive does not consist of documents, the research methodology will be classified as physical domain.

If the research problem is not based on data bank, it can be solved with formal deductive or inductive logic which can be classified as analytical strategy or internal logic; but if the research problem cannot be solved with formal deductive or inductive logic, it can be classified as non-research.

The Figure-3.2 presents the flowchart of the classification of methodology.
Flowchart for Classifying Methodology*

* Adapted from Buckley, Buckley & Chiang, Exhibit 26, p. 80.
Figure-3.3
The research methodology determines the type of research study. Figure-3.3 shows the graphical presentation of the types of research. According to Best, educational research has been classified into three types.
1. Historical research.
2. Descriptive research
3. Experimental research

1. Historical Research:

The research which deals with past events is generally called Historical research. This type of research describes past. The researcher studies the past events through some available sources and derives the conclusions which may help sometimes to understand the past events in a better way or may guide the present for better future. The investigator looks into the scattered events, analyzing and synthesizing them and establishes some truths unknown till the date. In this research, the investigator works as the historians do.

The sources used here for getting related information should be reliable and valid. The techniques generally used by the researchers are observation of important documents, field visits, interviews, referring related literature including criticism. The collection of diversified data and their study may provide some authentic vision to the researcher. Historical research design is the integration of data from various sources. The stages of the procedure of the research study involves identification of the problem and formulating the research question, research planning, data collection, data analysis and analysis of the source of the data. The researcher may find idea for research from anywhere from any person or situation or he may have such idea from reviewing previous researches. Research planning mainly focuses on access of the sources. ‘How’ and ‘where’ questions are to be answered. To collect data, the researcher has to visit persons or places or get some literature to gather information needed for his study.

For analyzing the data, an investigator should try to answer his research question by seeking some patterns in the data. Analyzing the sources of data, the investigator should look for the veracity of the data. The primary sources are more true and reliable than the secondary sources, so the researcher should try to find the primary sources instead secondary sources. After going through all these procedure, the researcher can have some good perception about the answer of his research question.

Thus, Historical research examines the past events or the series of past events or combination of various happenings to find the veracity of the events or make investigation into the roots of the present state.
When the investigator wants to explore the unknown, answer his question regarding past, justify relationship of something in past with the present, evaluate the performance or contribution of some person or institution or agency and want to solve some cultural issue, he has to undertake historical research study.

Historical research, however deals with past events, it can tell us something about the solution of the present problem. The present has its roots in the past so understanding the past vividly and accurately, the researcher may have solutions of the present problems. In historical research, the process of collecting and analyzing data and making notes is at the core of the research study. The investigator has to go back and forth while collecting data, reading, analyzing and synthesizing data, and writing.

The investigator can conduct the historical research when he wants to rectify some past events or find roots of the traditions or understand the relationship between various happenings or evaluate the contribution of an individual or organization.

The sources of information are most important in historical research. The observation of records, photographs, documents, relics and personal visits of places and interviews of the persons may provide a good source of information to the investigator. The printed and digital literature including personal diaries, back dated newspapers, magazines, yearbooks, reports, photographs and maps can be useful to the researcher to gather information related to his study. Relics include objects and articles used by a person that is to say, clothes, books, buildings, utensils, furniture and many such things. The national libraries, government offices, museums and authentic archives may provide valuable resources to the investigator for data collection.

The sources for data collection in historical research are of two types, primary sources and secondary sources. The primary sources are first hand original sources of past and available in the present time. The secondary sources are the second hand sources which are not original but based on and created from the primary sources. For example, visiting the person who has witnessed the event himself and getting information from him, will be the primary source of information; but in the absence of the witness of the event if someone narrates the stories told by the witness, will be the secondary source of the information. The primary sources are more reliable and valid than the secondary sources.
Before using the sources for data collection, the investigator should determine the authenticity of the sources. The process of determining the authenticity of the sources is known as the criticism of sources. The investigator has to go through external and internal criticism. The external criticism deals with the validity of the sources, while internal criticism deals with the reliability of the sources. To avoid the vagueness and uncertainty in the meaning conveyed by the sources, the investigator should use the strategy of positive criticism which helps him to understand the meaning appropriately. Three heuristics of negative criticism are used to determine the accuracy of the content of the sources, corroboration, sourcing and contextualization. Corroboration is comparing various documents to the similarity of the facts and figures of the content. Sourcing is identifying the source using information regarding writer, publication, place etc. Contextualization is finding the answers of when and where about the event.

Historical research design consists of five steps. The first step of the procedure of historical research is to identify the research problem and formulate the research questions or research hypothesis. Identification of the problem and formulation of research questions or hypotheses makes the investigator clear about his work. He realizes the need of the information useful for his study. He needs the information which can answer his research questions or confirm or disconfirm his hypotheses. Before the investigator follows the second step of data collection, he has to search for the sources of data collection. Then he follows the second step of the historical research procedure that is systematic data collection. After collecting the data, the evaluation of the data is the most important task for the investigator to undertake. Verification of the sources and collected data leads the investigator towards the third step of the procedure that is to synthesize the data to find some patterns of the information which leads him to confirm or disconfirm his hypotheses. The fourth step of the research design of historical research is interpretation of the observations and drawing conclusions. He draws conclusions based on the observations of the patterns emerging from the analysis and synthesis of the data. The fifth and the last step of the procedure is writing and publishing research report.

The graphical presentation of the historical research design is shown in the Figure-3.4.
Figure-3.4
Historical Research Design
A historical research aims at gathering, verifying, analyzing and synthesizing evidences of the past to answer the research question or test the hypothesis. Historical research study always deals with a variety of secondary and primary...
sources in the form of documents like diaries, reports, archives, logs, government records, maps, pictures, audio and video recordings which should have authenticity and validity.

**Descriptive Research:**

The research involving in studying present situation or phenomena is generally known as descriptive research. To make a survey of the present situation or know the status, the researcher adopts descriptive research study. This type of research generally does not deal with the causes of the situation. It just answers ‘what’ and describes the characteristics or traits. Descriptive research can be quantitative and qualitative.

Descriptive research is known by the research question formulated, research design adopted and the scheme of data analysis applied by the investigator. As descriptive research can be qualitative or quantitative, the investigator may collect quantitative and qualitative information for his study. The collected data may be in a numerical form which can be calculated and interpreted or it may be in verbal form which can be analyzed and synthesized. In descriptive research, the data collected are organized and presented in the form of tables, graphs and textual description so that the reader may understand the data distribution well. Descriptive statistics applied by the investigator reduce the large mass of raw data into manageable form. When data are of qualitative nature, the investigator uses description as a tool for organizing and analyzing the data in some emerging patterns which help the researcher as well as the reader to understand the qualitative research and its implications. Descriptive research aims at answering the question ‘what’, so the investigator generally uses the observational and survey methods for his study.

Descriptive research uses the descriptive statistical techniques like measures of central tendency (mean, median, mode), measures of deviation (standard deviation), measures of variance (t-test, f-test) percentage, correlation between variables. In descriptive research, the investigator can use more than one variables but it can be done with only one variable so he can describe the percentage of a single variable.

The descriptive research aims at describing, explaining and validating. Innovative exploration leads to description by organizing the results with
explanation following testing or validating explanations. Some research studies describe natural phenomena of some situation, activity, natural changes or relation between two or more different phenomena. The descriptive research explores some innovative knowledge unknown to or unnoticed by the people of the world.

The common results of descriptive researches are scientific and anthropological discoveries. Scientific researchers use telescope to describe universe and anthropologists observe life situations or cultural patterns to describe and educational researchers describe status and situations related to educational processes. Such descriptions may add something new to the pool of existing knowledge which can be helpful for the welfare of the mankind or make some reforms necessary to the situation.

Descriptive research is most importantly rely on the research tools adopted by the researcher and observation. Some of the descriptive researches last for many years to perfection in the measurement tools to have accurate and reliable results that can be generalized to the universe. Some of the descriptive researches aim at gathering statistical data to be helpful to the policy makers. A single or more than one methods of data collection are used in descriptive research. Anyhow, survey, interview and observation are generally adopted by the researchers undertaking descriptive research.

Descriptive research methods are surveys, correlational studies, observations and content analysis. Figure-3.5 shows the graphical presentation of the descriptive research methods.
Figure-3.5

Descriptive Research Methods

- Surveys
- Correlational Studies
- Observation
- Content Analysis
2. **Experimental Research:**

The study generally involving in manipulation of one or more variables is called experimental research. This type of research is more reliable than the others. The most of the scientific researches are undertaken using experimental method.

In this type of research, the investigator tries to look into the relationship between variables. The influence of one variable on other is at the core of the study. The variables are totally controlled here so this type of research is called true research.

The experiment in artificial situation is conducted to observe the effects on the variables so this type of research is called experimental research. Here the investigator manipulates the variable under study and controls the rest of the variables. When it is not possible for an investigator to control the variable, he randomizes the variable to reduce its effect.

The procedure of experimental research needs randomized selection of the sample. The investigator randomly selects the sample for his study from the population. The sample is divided into two randomly assigned groups, one being the experimental group and the other the control group. Both the groups are from the same sample so two different treatments are given to both the groups. Both the groups consist independent variable. The experimental group is given the treatment to be experimented and control group is given traditional treatment or rather no treatment.

The process of experimental research has five main steps. The first step is to determine the population. The second step is to select the sample for the study using suitable random selection sampling technique. The third step is to assign randomly experimental group and control group which are treated with two different treatments.

Figure-3.6 shows the graphical presentation of the procedure of the experimental research.
Experimental Research Procedure

Population

Randomly selected Sample

Randomly assigned Groups

Experimental

Control

Treatment A

Treatment B

Analysis and Interpretation of Data

Verify Predicted Results

Figure-3.6
Figure-3.7
Experimental Designs

Types of True Experimental Designs

- Post test only Design
- Pre test Post test only Design
- Soloman Four Group Design
- Factorial Design
- Randomized Block Design
- Cross over Design
There are various research experimental designs. Figure-3.7 shows the graphical presentation of the experimental designs. Post test only design, pre test- post test design, Solomon four group design, factorial design, randomized block design and cross over design.

**Post Test Only Control Group Design**

Post test only control group design follows the four steps. The post test only control group design is used where a pre test is not possible to administer. Due to the pre test, the participants are exposed to the treatment which affects the results. Here, post test only design is preferable. This design also follows the four steps, randomly assignment of the subjects into two groups, experimental and control group, treatment to the experimental group, administration of the post test to both the groups, access difference between experimental group and control group. These steps can be presented in a diagram as follows.

![Diagram](image)

R = Random Assignment  
O = Pretest or posttest observation or measurement  
X = Experimental variable or event  

Each row represents a different group of participants.  
Left-to-right dimension represents passage of time.  
Any letters vertical to each other simultaneously.

**Pre Test- Post Test Control Group Design**

Pre test- post test control group design is also known as classic controlled experimental design and randomized pre test post test design. This design also follows the five steps, randomly assignment of the subjects into two groups, experimental and control group, administration of the pre test to both the groups, treatment to the experimental group, administration of the post test to both the
groups, access difference between the pre test and post test for both the groups. These steps can be presented in a diagram as follows.

R = Random Assignment
O = Pretest or posttest observation or measurement
X = Experimental variable or event

Each row represents a different group of participants.
Left-to-right dimension represents passage of time.
Any letters vertical to each other simultaneously.

Figure-3.8 shows the graphical presentation of pre test- post test experimental design.
Solomon Four Group Design
Solomon four group design is used to avoid the limitations of the pre test- post test design. In this design there are two extra control groups which reduce the influence of confounding variables. Solomon four group design is a very complex design. An investigator feels it very difficult to set up this design. It is also difficult for an investigator to analyze the collected data. Yet this design is useful to avoid the internal validity threat. It avoids the pre test influence. The design is diagramed as follows.

<table>
<thead>
<tr>
<th>R₁</th>
<th>O₁</th>
<th>X</th>
<th>O₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>R₂</td>
<td>O₂</td>
<td>O₄</td>
<td></td>
</tr>
<tr>
<td>R₃</td>
<td>X</td>
<td>O₅</td>
<td></td>
</tr>
<tr>
<td>R₄</td>
<td>O₆</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R = Random Assignment  
O = Pretest or posttest observation or measurement  
X = Experimental variable or event  
Each row represents a different group of participants.  
Left-to-right dimension represents passage of time.  
Any letters vertical to each other simultaneously.  

In this design, the first two groups are treated as pre test- post test design. Randomized assignment of the sample groups is also the same as pre test- post test design. The investigator can know whether the act of pre testing influences on the results when he compares the results of the post test of Group C and Group D marked by line D. The difference between the post test results of Group C and D from The results of Group A and B indicates the effect of the pre test on the results. When the results of the pre test of Group B are compared with the results of the post test of Group D, the investigator can know about the external factors influencing the results.
Figure-3.9
Solomon Four Group Design
The comparison between the Group B posttest and the Group D posttest shows whether the pretest itself has affected behavior, independently of the treatment. If the results are significantly different, then the act of pretesting has influenced the overall results and is in need of refinement. Figure-3.9 shows the graphical presentation of Solomon four group design.

**Factorial Design**

The study involving only one independent and one dependent variable is the simplest study but when more than one independent variable are involved in the research process, the investigator has to select factorial design for his study. The independent variables are also known as factors. Factors can be defined as when there are multiple independent variables in any research study, the research design for the study is known as factorial design.

A factorial design has not only two independent variables; but there may be more than two as per the investigator’s choice. The factorial design differs from simple design because it has more than one independent variable. In simple design, the investigator studies effect of each independent variable on dependent variable but in factorial design, the investigator looks into the combined effect of independent variables on dependent variable.

Factorial design is flexible for the exploration of the treatment in the study. The investigator can study the treatment variations using factorial design for his research. The factorial design is efficient and effective to study the combined effect independent variables. It is also feasible for an investigator to combine the studies of independent variables instead of conducting individual studies of independent variables. If the investigator wants to look into the interactive effects of the variables, the factorial design is the only effective way for him to select.

Factorial design varies according to the number of factors. Each independent variable is a factor and the level if the variable is subdivision of a factor. When there are two independent variables, a 2 x 2 factorial design is adopted. 2 x 2 means each factor has two levels. Similarly, a 2 x 4 design means two subdivisions for one factor and four subdivisions for another factor. When there are three independent variables having two levels for each, the design will be called 2 x 2 x 2 factorial design. An investigator can test more than two factors but the design becomes more
complex. The graphical presentation of factorial design having three independent variables having two levels for each is shown in Figure-3.10 and the graphical presentation of four independent variables having three levels for each is shown in Figure-3.11.

**Figure-3.10**
2x2x2 Factorial Design
### 4 x 3 Simple Factorial Design

<table>
<thead>
<tr>
<th>Control Variable</th>
<th>Experimental Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treatment A</td>
</tr>
<tr>
<td>Level I</td>
<td>Cell 1</td>
</tr>
<tr>
<td>Level II</td>
<td>Cell 2</td>
</tr>
<tr>
<td>Level III</td>
<td>Cell 3</td>
</tr>
</tbody>
</table>
Randomized Block Design

The experimental research design known as randomized block design is more or less similar to stratified sampling technique in research. To minimize the variance in the data, various blocks or groups are constructed. As in the stratified sampling technique, the investigator divides the population in various strata or homogeneous groups; in randomized experimental design, he divides the sample into blocks or homogeneous subgroups. The investigator implements his experimental design within each homogeneous individual block. The principle that works in adopting randomized block design is that the variability can be reduced by dividing the sample into subgroups as the variability of the entire sample is obviously more than that of each individual subgroup. By blocking the sample into subgroups, the investigator may increase the efficiency of the treatment effect within the blocks because the estimate of the treatment effect within an individual subgroup is more efficient than the estimates of the entire sample.

Thus, by pooling such more efficient estimates across the blocks, an investigator may have an overall more efficient estimate for the entire sample.

The table below shows a randomized block design for a hypothetical experiment.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Treatment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Male</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Female</td>
<td>250</td>
<td>250</td>
</tr>
</tbody>
</table>

Subjects are assigned to blocks, based on gender. Then, within each block, subjects are randomly assigned to treatments (either A or B). For this design, 250
men get the A treatment, 250 men get the B treatment, 250 women get the A treatment, and 250 women get the B treatment. It is known that men and women are physiologically different and react differently to different treatments. This design ensures that each treatment condition has an equal proportion of men and women. As a result, differences between treatment conditions cannot be attributed to gender. This randomized block design removes gender as a potential source of variability and as a potential confounding variable.

The randomized block design is used when the investigator is interested in how several treatments affect a continuous response variable (Y). The treatments may be the levels of a single factor or they may be the combinations of levels of several factors. Suppose there is a total sample N which is divided into experimental units nt to which different treatments are going to be applied. Thus, N = nt. The completely randomized (CR) design randomly divides the experimental units into t groups of size n and randomly assigns a treatment to each group whereas the randomized block design divides the group of experimental units into a homogeneous groups of size t. These homogeneous groups are called blocks. The treatment is then randomly assigned to the experimental units in each block – one treatment to a unit in each block.

A randomized block design is assumed to be a two factor experiment. The factors are blocks and treatments. There is on observation per cell. It is assumed that there is no interaction between blocks and treatments. The degrees of freedom for the interaction are used to estimate error. If the treatments are defined in terms of two or more factors, the treatment sum of squares can be split into main effect and interactions.

The graphical presentation of a randomized block design is shown in Figure-3.12.
Figure-3.12
Randomized Block Design
Here, we can see a simple example. Let's assume that we originally intended to conduct a simple posttest-only randomized experimental design. But, we recognize that our sample has several intact or homogeneous subgroups. For instance, in a study of college students, we might expect that students are relatively homogeneous with respect to class or year. So, we decide to block the sample into four groups: freshman, sophomore, junior, and senior. If our hunch is correct, that the variability within class is less than the variability for the entire sample, we will probably get
more powerful estimates of the treatment effect within each block. Within each of our four blocks, we would implement the simple post-only randomized experiment.

Notice a couple of things about this strategy. First, to an external observer, it may not be apparent that you are blocking. You would be implementing the same design in each block. And, there is no reason that the people in different blocks need to be segregated or separated from each other. In other words, blocking doesn't necessarily affect anything that you do with the research participants. Instead, blocking is a strategy for grouping people in your data analysis in order to reduce noise -- it is an analysis strategy. Second, you will only benefit from a blocking design if you are correct in your hunch that the blocks are more homogeneous than the entire sample is. Blocking design yields the stronger treatment effect. But this is true only because we did a good job assuring that the blocks were homogeneous. If the blocks weren't homogeneous -- their variability was as large as the entire sample's -- we would actually get worse estimates than in the simple randomized experimental case.

**Cross over Design**

A crossover design is a design in which every unit of the experiment receives each treatment. It is like a counter balanced design. This design produces more efficient results than that of parallel design.

The graphical presentation of crossover experimental design is shown in Figure-3.13.
All experiments conducted in the laboratory in the field of science are experimental researches. Identifying the problem, defining it, formulation of
hypothesis and testing the hypothesis by using statistical techniques to arrive at the conclusions for establishing universal truths are the steps generally followed by the investigators of this type of research. The researcher tries to quantify the qualitative traits to derive the conclusions. The conclusions are always based on the observations of the testing of the hypothesis. The results depend on whether the hypothesis is accepted or rejected and at what significant level.

Experimental research requires randomly selected sample, total control over variables and appropriate statistical measurement techniques to test hypothesis. Experimental research is widely used to find the cause and effects. This research method can compare two instructional strategies and show which one is more effective and better but it cannot answer the question ‘why’.

For the present study, the descriptive research method was adopted. It was a survey of the attitudinal facts about the higher secondary students of science stream in the schools of Gujarat.

Some steps like defining the problem, survey of the related studies, arriving at generalizations etc. are some of the common steps. Looking back at the problem and objectives of the study, the investigator has come to the conclusion that the present study falls under the area of descriptive research. This type of research involves the description, recording, analysis and interpretation of condition that exists. This research mainly uses quantitative design, for which data was collected from the students of the science stream of higher secondary schools of Gujarat through simple descriptive survey questionnaire or statements. The research instrument used to collect required data was a Likert-type scale to collect and measure each variable of the study.

2.3 TOOLS USED IN THE STUDY

In any kind of research, collection of information required for the study is at the core of the study. There are many ways and means to collect important data for the research study. To collect sufficient data required for the study, the researcher should select the proper instrument which can collect reliable and valid information for the study.

There are many different tools to help the researcher for collecting useful data for his study. The various devices can be used for various kind of information. There are some apparatus or appliances which can be used as research instrument for data collection. Each instrument is unique in itself for collecting particular data so
selection of appropriate tool is the most important in the procedure of research study. The reliability of the results of any research depends on the reliability of the data collected. Similarly the reliability of data collected depends on appropriate selection of the tool to collect data.

As it is said different kind of tools can be used for different kind of information according to the m\nature of the research problem. Hence to make a proper selection of his tools, the researcher should know different tools with their qualities and limitations. Sometimes the appropriate tool for collecting data required for the study is not available. At that time the researcher has to construct his tool himself. That is to say, the researcher must not only be familiar with different kind of tools available but he must also know how to construct the tool. Moreover, the researcher should also be well aware of the techniques useful for his research work. A technique means a way or a procedure to accomplish a more complicated and complex task very easily, systematically and scientifically consuming less time and energy. A technique is an art or a skill to work in a more practical way of bringing quality in work. Thus the tools and techniques both are very important for an investigator to know.

The generally used in research studies can be classified as inquiry forms, observation, interview, sociometry and psychological tests. Inquiry forms are used to gather information. They are questionnaire, checklist, schedule, score card, rating scale, attitude scale, opinionnaire. Observation, interview and sociometry are used as a research tool as well as a research technique. Psychological tests are of five types, achievement tests, aptitude tests, intelligence tests, interest inventories and personality measures. The various types of research instruments are shown in the Figure-3.14
Research Tools and Techniques

Inquiry Forms
- Questionnaire
- Checklist
- Schedule
- Rating Scale
- Attitude Scale
- Opinionnaire
- Score Card

Interview

Observation

Sociometry

Psychological Tests
- Achievement Test
- Aptitude Test
- Intelligence Test
- Interest Inventory
- Personality Test
1. Inquiry Forms:

Inquiry forms are used for getting information about a person, object or situation. They can be individual inventories or questionnaires. Some other forms of inquiry are checklist, schedule, rating scale attitude scale, opionnaire and score card. Let us see these inquiry forms with their nature and limitations. A graphical presentation of inquiry forms is shown in Figure-3.15.

Questionnaire:

A questionnaire is a series of questions which can be in the written form or in typed or printed form. It is a set of questions used as an instrument to gather information from the respondents with a view to finding the answer of the research question. Each question in a questionnaire is followed by choice of answers. A questionnaire is an instrument which is used by an investigator for a research purpose whether it is a survey or statistical analysis.

The questionnaire is very common in all the inquiry forms. It is very often used in research studies to collect required data for the study. As its names suggests, questionnaire is sequence of questions. For the first time, Sir Francis Galton used questionnaire as a research tool and made it popular. The questions related to the inquiry for the research problem are constructed and used for the collecting necessary information from the respondents. In scientific research studies, the questions are constructed to be statistically calculated and analyzed for the interpretation and conclusions. Questionnaires are very common in descriptive researches like surveys. Sometimes the researchers use them verbally or telephonically. Questionnaires are used only where respondents are able to read. This is a limitation of this tool. So in some situations, questionnaires are not useful for surveys. A questionnaire can have yes/no questions, multiple choice questions or open answer questions. Questions should be framed in a very simple language. They should not be ambiguous or confusing to the respondents. They should be relevant to the research problem.

A questionnaire is a list of questions to be used for the purpose of research study. The questions in the questionnaire are to be asked to the respondents and they are constructed to collect information required for the research study. Questionnaires are not only used to collect necessary data for the research but they make data comparable and amenable to analysis. Questionnaires are also used to minimize bias in formulating and asking question and to make questions engaging and varied.
Figure-3.15

Inquiry Forms

- Questionnaire
- Checklist
- Schedule
- Rating Scale
- Attitude Scale
- Opinionnaire
- Score Card
- Psychological Tests
Questionnaires are more affordable than any other instrument for an investigator as they are administered directly distributing them to the respondents and getting responses at the same time or they can be posted to the respondents and responses can be gathered in the same way. Sometimes, the researcher uses telephone service or email for collecting responses from the respondents. Questionnaires have their standardized answers so it becomes easy for the respondents to respond and the investigator can collect the data without much effort. However, respondent friendly this instrument is, it has a great limitation that it cannot be used for certain demographic groups such as for very small children and for the persons who do not know reading. Questionnaires are used only for the respondents who know reading and can comprehend the language with sense that is to be conveyed by the respondents. In this sense, the questionnaire has the problems regarding linguistic construction and selection of words.

A questionnaire can be of two types, the one having questions to measure separate variables and the other having questions aggregated to make one instrument to measure some particular variable. The first type of questionnaires is generally used in survey type research studies whereas the second type of the questionnaires is commonly part of tests. Questions to measure separate variables in a questionnaire inquire about the facts, behaviours or preferences of the respondents while questions creating a test or an index or a scale measure attitude, traits or status of respondents.

Generally in a questionnaire, the respondents have to answer a number of questions in a set format. These questions are of two types, open-ended questions and close-ended questions. Open-ended questions are those for which options or predefined answers or categories are not given. The respondents do not get any fixed set of possible answers. They have to write their own responses. Open-ended questions are broad in view and sometimes vague. Such questions are completely unstructured. For example, “What is your opinion on intelligence?” The word association exercises are also open-ended questions where the respondents write any word that comes first to their mind. The exercises of sentence completion, story completion, picture completion and Thematic Apperception Test are open-ended questions. Closed-ended questions are yes/no type questions, multiple choice type questions and scaled questions.
In a questionnaire with the open-ended type of questions, the respondents have to construct their own answer. In a questionnaire with closed-ended questions, the respondents have to choose answer from the choices given below each question. The closed-ended questions in a questionnaire should be exhaustive and mutually exclusive. The responses to be achieved by the respondents for the closed-ended are of four types based on the number of options. They can be dichotomous with two options, nominal-polytomous with more than two unordered options, ordinal polytomous with more than two ordered options and bounded continuous with continuous scale. In the questionnaires with open-ended questions, the responses of the respondents are coded into scale later on.

The sequence of the questions in a questionnaire should follow the logical rules to achieve the best responses. The flow of questions should be from the least to the most sensitive questions. The sequence of the questions should follow the order from factual and behavioural to the attitudinal. The questions should also be arranged from the more general to more specific. The questions can be ordered as screens following warm-ups following transitions following skips following difficult following changing formula following classification or demographic questions. Screening questions help to inspire the respondents to complete the questionnaire. Warm-up questions are simple general questions particularly not related to the objectives of the research study which help to create interest in the study among the respondents. Transition questions help to integrate the different areas of the study. Skip questions suggest the respondents whether to continue with the following question or to skip over to some other question. Difficult questions require the willingness of the respondents to respond so they should be kept towards the end of the questionnaire as the respondents are more willing to respond when they are at the end of their task. Classification or demographic questions make the respondents uncomfortable and unwilling to respond, so such questions should be at the end of the questionnaire.

The investigator should carefully construct the questions for the questionnaire. He should use the simple language which can be easily interpreted by common people. He should select the statements which can seek the different opinions of the respondents. The investigator should think of the open-ended questions when the possible answers have been over. While formulating the question, the investigator should include one aspect in one question. It is desirable for an investigator to use positive statements instead of negative or double negative statements. The researcher
should never rely on any assumption about the respondent. The questions should be framed in a very simple, clear, comprehensive language which can be easily understood by the respondents of all educational levels. Spellings, grammatical constructions and punctuations should be used correctly. Questions should not be biased or leading the respondents to select particular answer.

There are various modes of administering the questionnaire. When the investigator asks the respondents to express their responses orally, it is known as face-to-face questionnaire administration. When the questionnaire is in the form of written, typed or printed; the respondents have to use pen or pencil to express their responses. This mode of administration of a questionnaire is called paper-and-pencil questionnaire administration. When the investigator presents the questions on a computer and the respondents also answer through computer, it is called a computerized questionnaire administration. Sometimes the selection of items is presented on the computer and the respondent selects the answer, computer selects the next item according to the ability and trait of the respondent perceived by the selection of the respondent for the previous item. Such mode of administering a questionnaire is called adaptive computerized questionnaire administration.

Although a questionnaire is affordable, easy to administer and analyze, some problems may occur in using it as a research instrument. The investigator is not able to know whether the respondent has understood the question. The respondents may select the options even without reading and understanding questions. Many a times, respondents are not willing to give their responses. Sometimes, they give wrong answers purposefully. The specific questions may not provide adequate and appropriate information. The respondents do not care to return the questionnaire. The questionnaires may not produce representative results when they are not collected using appropriate sampling techniques to have representative population.

Checklist:

A checklist is, as its name suggests, a list of items to be checked. The list here should be consistent and complete.

Schedule:

A schedule is also type of checklist. It is basically a timetable so it is used as a time, task and effort management instrument. It is also a list of time, tasks to be accomplished, actions to be taken, events in chronological order. Creation of
schedules is as old as human activity. Preparing a schedule requires decision making ability on the part of a scheduler. Balancing the time, ordering the tasks with commitment of the variety of resources requires resourcefulness on the part of scheduler. In experimental researches schedules are important to be strictly followed. Schedules can have short term planning or long term planning. It can be daily planning, weekly planning or monthly or annual planning. When the researcher wants to fulfill the set goals in definite time duration, schedules are useful. Generally schedules set definite time for definite event but sometimes when time is not set, the list of events or tasks or stages of the procedure is displayed in an orderly form.

Score-card:

A record or report of statistical details is generally known as a score-card.

Rating Scale:

A set of certain traits or categories form a research instrument called a rating scale. It is an evaluative device which provides information about some quality or attribute. The rating scale measures qualitative as well as quantitative attributes.

The rating scales are of three types, ordinal, interval and ratio. When data are measured at ordinal level, numbers show the relative position of items. Ordinal rating scale cannot indicate the magnitude of difference. The examples of ordinal scales are attitude scales and opinion scales. A ten point rating scale is very commonly used. A Likert type scale is also often used in surveys. When the data are measured at the interval level, numbers indicate magnitude of difference between items, but absolute zero point is not there. Scale of temperature is an example of interval level rating scale where difference between numbers matters but zero does not matter. When the data are measured at ratio level, numbers indicate magnitude of difference and there is a fixed zero point. Examples of ratio level rating scales are scales measuring age, income, price, costs, sales revenue, sales volume and market share. Ratio can be calculated.

Attitude Scale:

A scale used to measure attitude is called attitude scale. Attitude scale measures relative quantity of attitude of a person with others. Two types of attitude scales developed in psychology and sociology are popular. The scale developed by
Louis Leon Thurstone in 1928 was the first attitude scale to measure attitudes towards religion. A Thurstone type attitude scale includes statements regarding some specific variable or problem. Each statement in the scale has a numerical value showing the degree of favourable or unfavourable. The respondents have to check each statement. The mean score shows their attitude. Thurstone’s theory of pair comparison is quite complex which makes it difficult to be applicable.

A Likert scale is a psychometric scale commonly involved in research that employs questionnaires. It is very common in survey research. A Likert scale is not the same as a rating scale. Sometimes a rating scale and a Likert type scale are considered as the same but Likert distinguished his from a rating scale. A rating scale does not look into the underlying feelings or intentions with the degree of intensity. A Likert type scale provides levels of agreement or disagreement to the respondents. Thus the intensity of the attitude of the respondent towards certain person, situation or object can be judged by the researcher in using a Likert type scale.

A Likert scale is a sum of responses from the respondents. The responses are received on Likert items by making tick marks or encircling by the respondents. Likert items are comprised of set of statements which the respondents have to evaluate. Through this instrument generally level of agreement or disagreement is measured. The response levels in this type of scale can be five, seven or nine but five point response level is very common in research studies. The items selected in Likert type of scale are positive as well as negative. The five point response level of Likert item generally include strongly agree, agree, neutral, disagree, strongly disagree but sometimes even point scale is also used. Here there are only two levels of responses, agree and disagree, the neutral level is not there. The neutral option helps the respondent when he feels indecisive about his response to the item but in the forced choice method, the respondent has no choice to select none. Likert scale may be distorted by bias such as central tendency, acquiescence or social desirability. Equalizing the number of positive and negative statements, the investigator can avoid the acquiescence bias but avoiding central tendency and social desirability bias seems to be difficult for an investigator.

Likert scale is summative scale so scoring of the scale can be achieved by summing the item responses. Each item may also be analyzed. For getting the score
of the items, numerical values are given to the response levels but equidistance should be maintained between the numerical values. The five response levels represent the interval levels of measurement.

For the data analysis of Likert scale, the statistical techniques generally used are chi-square, Cochran Q and McNemar test. For validation of the standard accepted for the likert scale, Consensus Based Assessment- CBA is used.

Opinionnaire:

A set of collected statements to be accepted or rejected by the respondents. Generally opinionnaires are used in surveys.
2. Observation:
Observation is an important research instrument for data collection and also it is an important stage of research procedure. Observing the subject in its natural environment, the investigator collects the information about the subject. In a controlled observation, the investigator puts the subject in some artificial controlled situation and notes down the information he receives in the form of reactions. Observation is a tool as well as a technique which requires appropriate use of senses of an observer. The researches in the field of science require laboratory experiments where recording of observations leads the researcher towards results. The reliability of results of the experiment depends on the reliability of observations.

The most important method of data collection in qualitative research is observation as interviews also require observation on the part of an investigator. This technique is not so structured as experimental design and not so unstructured as the technique of in depth interviews. The observation techniques are of various kind but they can be divided into two major groups, namely direct and indirect observations.

Direct observations are the observations out of the laboratory. Instead they are sought in the natural surroundings of the respondents. Sometimes an investigator finds it unethical to put the respondents in the laboratory for the purpose of getting observations for his research study so he has to go to the respondents in their natural locations to get observations for his study. This type of observations is useful for an investigator when it is impossible for him to work in the laboratory. For example if the investigator wants to study the students’ verbal abuse while they quarrel or fight in the school, he cannot put the students in an artificial environment of the laboratory where they will be asked to quarrel or fight. Here the investigator has to go to the events of quarrel or fight whenever and wherever they occur in the school. Direct observations can be observations with or without interventions. They can be participant observations or structured observation and field experiments.

Observations without intervention are also known as naturalistic observation. The investigator is able to study the natural behavior of the respondents using this method. This observation technique is quite opposite to observation of an experiment in the laboratory where an artificial environment is created for the purpose of obtaining observations to get necessary data for the research study.
Observations with some interventions are generally used by psychologists for their research studies. When the researcher wants to study the behavior or response of an individual some specific given settings instead of natural settings, he has to use theism ethos of observation with intervention. This is quite opposite to the naturalistic method of observation. In participant observation method, the researcher himself participates in the situation along with the respondent. The participation of the observer in the situation makes his observations more acute and realistic. Participant observations can be done in two ways namely disguised or undisguised ways.

In the participant observation, the researcher himself takes part in the situation but in structured observation he creates situation for the respondents to behave to provide him observations. It is a middle way strategy to participant observation and naturalistic observation as structured observations are used in natural surroundings as well as in scientific laboratory. The researchers studying in the field of clinical or developmental psychology prefer the method of structured observations. The investigator uses this method when it is difficult for him to record his observations in natural realistic settings and also it is difficult for him to record his observations in artificially controlled environment of any scientific laboratory. Thus creating the situation in natural settings and manipulating his independent variables, the investigator studies the behavioural patterns of his respondents. Here the control on independent variable is required, otherwise it will not be possible to get genuine observations.

The method of field experiment is quite similar to the method of structured observations. In the structured observation, the investigator creates an artificial situation in the natural settings of the respondents manipulating one or more independent variables of his research study. Similarly in field experiment also, the investigator manipulates the independent variables in the natural situations but field experiments require the maximum control of the investigator on the variables. Thus the fundamental difference between these two types of observations is that of the degree of control of an investigator over the situation and in manipulation of the independent variables. Unlike naturalistic observations, field experiments permits the investigator to generalize his results.
The data collection method of indirect observation is used when any of the direct observation method is not feasible to use for an investigator. When the investigator does not want to be noticed or recognized, he uses indirect method of observation. Sometimes it is unethical to observe certain behaviours or situations; to avoid such ethical problem, the investigator prefers to adopt indirect method of observation.

There are three common ways to observe the sample to collect evidences to derive at the results of the study. Indirect observations are made through physical trace evidences, archival records and document review.

3. Interview:

An interview is more reliable than questionnaire as the investigator can observe the tone of voice, facial expressions and gestures and body language of the respondent. A conversation between two or more persons is normally called an interview. It is very common now a day due to the popularity of television, radio and other printed and digital media. For collecting qualitative information, interview is very useful technique.

In researches like surveys, interviews are also very formal and pre planned. Interviews are more structured in quantitative researches unlike interviews in qualitative researches. As Leedy and Ormrod (2001) said an investigator is not allowed to ask anything else except the scheduled list of questions set previously in a structured type of interview. Such structured interviews are conducted in three ways, they can be face to face interviews, telephonic interviews or personal interviews assisted by the computer.

1. Face to Face Interviews: Face to face interview is more lively and advantageous than telephonic or computer assisted interviews. Here the interviewer and interviewee are face to face so the interviewer can establish a good rapport with the respondent and find his or her cooperation in providing the information required for the research study. In survey type researches, face to face interview technique of data collection is most commonly used. Here the researcher may have a chance to clarify his question, help the respondent in confusion and notice the facial gestures of the respondent while replying the question. Thus face to face interviews are more advantageous than other techniques of collecting data but this technique is feasible only when the sample is
small, otherwise, it can be proved to be very costly and time consuming when sample is large and scattered.

2. Telephonic Interviews: Telephonic interviews are more time saving and cheaper in comparison to face to face interviews. Telephone is a common and popular device of communication now a day. An investigator may contact any respondent if he or she has a device of telephone. The advantages that we find in face to face interview are not found in telephonic interview. The interviewer can only listens to the voice of the respondent, he cannot see him, so his facial gestures cannot be seen, but the interviewer can judge the tone of voice of the respondent. However, the video telephonic devices may solve this problem. This technique of data collection is not so advantageous as responses are not received so easily in telephonic interviews as they are found in face to face interviews. Yet this technique is more advantageous than mailed questionnaires. The sampling technique can be biased as the investigator can neither access the entire population nor he can add the members of the population without telephones into his sample.

3. Computer Assisted Interviews: Interviews assisted by the computer, generally known as CAPI (Computer Assisted Personal Interview) are just like face to face interviews but here the research notes down the responses in his laptop or personal handy computer like devices, instead of writing in a notebook. The computerized database can be prepared very easily and speedily by using the technique of computer assisted person interview. This technique is economical in the matter of time and advantageous for collecting valid and quality data for an investigator. Use of computer has become very common now a day so it is a desirable technique of collecting data for any research study but it can be proved to be expensive and specific skill oriented on the part of the investigator.

   Sociometry:

   An instrument to measure sociability of an individual is known as sociometry. Jacob L. Moreno who was a psychotherapist studied on the relationship between social structures and psychological well-being of an individual. He developed sociometry for the first time to be used for his study. Since then, sociometry is the sole instrument to know sociability of an individual and its use is very common in the researches especially in the field of sociology and other branches of humanities.
The word sociometry is derived from Latin ‘socius’ and ‘metrum’ words meaning ‘companion’ and ‘measure’ respectively.

5. Psychological Tests:

The tests which are constructed with a view to measuring traits, qualities or capacities of an individual are known as psychological tests. In psychology, we have achievement tests, aptitude tests, intelligence tests, personality tests and interest inventories.

Achievement test:

A test to measure individual’s knowledge or skill is generally known as achievement test. A standardized question paper of any grade can be called an achievement test. To find out the fulfillment of the aims and objectives and achievement of the educational goals, achievement tests are useful. To know the quality of classroom instruction, effectiveness of teachers and effectiveness of instructional planning and deciding promotional grades of the students, the achievement tests are used. Achievement tests are used for diagnostic and remedial purpose too. To establish the superiority of certain method of teaching to some other method or methods, achievement tests are the most required research instruments.

Aptitude Test:

A test constructed to measure an individual’s innate ability, competency or talent in some specific field. Aptitude is not achieved, acquired or learned knowledge or skill but an innate ability associated with the nature or temperament of an individual by birth. A test which measures aptitude is called aptitude test. Aptitude tests can be classified considering the cognitive abilities which they measure.

Intelligence Test:

A test to measure an individual’s intelligence is called intelligence test. The score of an intelligence test is known as IQ intelligence quotient. IQ tests are verbal
or nonverbal. IQ has positive correlation with achievement. The student’s mortality, his family background, biological inheritance, learning opportunities etc, influence on intelligence.

Interest Inventory:

Generally people like to do certain activities more than the others. Likings of people are innumerable. To find out the area of an individual’s liking or his hobby, interest inventory is used.

Personality Test:

Test used to measure an individual’s personality traits is called personality test.

Thus several tools have been used in the study of present situation e.g. direct questioning, direct observation, questionnaire and scale. The tool which is usually used by the research workers to measure present situation is the questionnaire or scale of which reliability and validity can be tested.

The tool which is usually used by the research workers to measure attitude is the attitude scale of which reliability and validity can be tested. The standard attitude scale is not available to measure attitude of student of science stream of higher secondary schools of Gujarat towards opting Mathematics group.

The investigator used the attitude scale prepared by him for his research work.

2.3.1 ATTITUDE SCALE

Data collection is the important stage in any type of research study. For data collection the selection of an appropriate tool needs a great care and thoughtfulness. The information required for the investigation can be collected through various sources. Data necessary for the study should be relevant to the research problem and also enough in quantity and adequate in quality. The information collected should have the quality of reliability, validity and sufficiency.

There are various devices for collecting required data. Such devices are known as research tools or research instruments. The instruments, appliances or apparatus used for collecting required data should be selected according to the nature of the information and objectives of the research study. The selected tool should be suitable for gathering suitable information to fulfill the requirement of the objectives of the study. For the fulfillment of more than one objective, the investigator may use more
than one research tools to collect the various types of information required for the investigation.

There are different types of research tools to collect different types of information. There are inquiry forms like questionnaire, checklist, score card, schedule sheet, rating scale, opinionnaire, attitude scale and others. Some other type of information requires techniques like observation, interview, sociometry and so on. Some more specific psychological traits can be known using psychological tests. The investigator should have the knowledge of all research tools, their nature and advantages and their limitations. Sometimes the researcher does not find any suitable tool which can be suitable to collect information necessary for his study. When any readymade appropriate tool is not available, at that time the researcher needs to construct a suitable tool himself. Thus the investigator should have the knowledge of constructing and administrating the research tool successfully and effectively.

In the study of attitude, several tools can be used, e.g. direct questioning, direct observation, questionnaire and attitude scale. The tool which is usually used by the researchers to measure attitude is attitude scale. To measure attitude of higher secondary students towards opting Mathematics group, a readymade tool is not available. Hence, the investigator constructed the attitude scale for assessing the attitudes of higher secondary students towards opting Mathematics group.

The investigator, for his present study, could not find the readymade tool to gather necessary information. He had to measure attitude of the higher secondary students towards opting mathematics group of subjects. For this he needed attitude scale which can measure students’ attitude towards opting mathematics group in science stream of higher secondary schools. So the investigator decided to construct the tool himself. For the present research study, the researcher used the attitude scale constructed on the bases of the theory of Likert.

A Likert type Attitude Scale is generally selected by the researchers. Most commonly in survey researches, Likert type attitude scale is more suitable to collect specific data. It is a psychometric scale consisting statements related to the inquiry topic or variable.

For the present study, the five point Likert type scale was constructed by the researcher and used for the purpose of collecting required data for the study.
For the present study, the investigator used the attitude scale constructed on the bases of the theory of Likert. A Likert scale is a psychometric scale commonly involved in research that employs questionnaires. It is very common in survey research. A Likert scale is not the same as a rating scale. Sometimes a rating scale and a Likert type scale are considered as the same but Likert distinguished his from a rating scale. A rating scale does not look into the underlying feelings or intentions with the degree of intensity. A Likert type scale provides levels of agreement or disagreement to the respondents. Thus the intensity of the attitude of the respondent towards certain person, situation or object can be judged by the researcher in using a Likert type scale.

A Likert scale is a sum of responses from the respondents. The responses are received on Likert items by making tick marks or encircling by the respondents. Likert items are comprised of set of statements which the respondents have to evaluate. Through this instrument generally level of agreement or disagreement is measured. The response levels in this type of scale can be five, seven or nine but five point response level is very common in research studies. The items selected in Likert type of scale are positive as well as negative. The five point response level of Likert item generally include strongly agree, agree, neutral, disagree, strongly disagree but sometimes even point scale is also used. Here there are only two levels of responses, agree and disagree, the neutral level is not there. The neutral option helps the respondent when he feels indecisive about his response to the item but in the forced choice method, the respondent has no choice to select none. Likert scale may be distorted by bias such as central tendency, acquiescence or social desirability. Equalizing the number of positive and negative statements, the investigator can avoid the acquiescence bias but avoiding central tendency and social desirability bias seems to be difficult for an investigator.

Likert scale is summative scale so scoring of the scale can be achieved by summing the item responses. Each item may also be analyzed. For getting the score of the items, numerical values are given to the response levels but equidistance should be maintained between the numerical values. The five response levels represent the interval levels of measurement.
For the data analysis of Likert scale, the statistical techniques generally used are chi-square, Cochrann Q and McNemar test. For validation of the standard accepted for the likert scale, Consensus Based Assessment- CBA is used.

**QUALITY OF THE RESEARCH INSTRUMENT**

**Construction of the Tool:**

The investigators made a thorough search for appropriate instruments to find out the attitude among the students. Since there was no appropriate tool, a tool was constructed.

Procedure followed for Construction of the Tool:

The development of tool was done in several phases as explained below.

1. Collection of relevant information regarding students’ attitude towards opting mathematics group.
2. Item pooling and arrangement of items.
3. Experts opinion and evaluation of items.
4. Finalization of the tool.

Phase – I:

Collection of relevant information regarding students’ attitude towards opting mathematics group.

To ensure adequate coverage of all the possible and likely sources giving relevant information were approached. For the purpose of preparing the universe of items indicating various dimensions, the following sources were tapped.

1. Discussion with personnel, School student, teachers, educationists and parents.
2. Related Research studies.
3. Inventories developed by researchers.
4. Investigators observation of students in different levels of school education.

(a) Discussion with Personnel:

For the purpose of obtaining relevant information regarding students’ attitude towards opting mathematics group, some personnel in the field like educationists, heads of Institutions, experience teachers, and researches in this field were interviewed.
The information thus collected likely revealed the different aspects of students’ attitude towards opting mathematics group.

(b) Discussion with School Students:
Some school students of both sexes were approached and group discussions were arranged in small groups regarding the aspects of environmental awareness for clean and green India.

2. Related Research Studies:
From the results of related research studies reviewed relevant ideas concerning students’ attitude towards opting mathematics group.

3. Inventories developed by researchers:
Inventories developed by researchers for their study were reviewed to get an idea of the format and construction procedure.

4. Investigators observation of students in different levels of school education:
The investigator as a student has observed certain problems of others. This observed experience has helped in adding information to the questionnaire.

Phase – II – Item Pooling:
All the information collected through various sources and the investigator’s own experience as a learner were analyzed and a number of items were constructed for the questionnaire.

Item selected for the questionnaire consisted different aspects of students’ attitude towards opting mathematics group.
They may be broadly classified as follows.

1) Availability of Resources: It refers to human and physical resources and learning atmosphere as a whole.
2) Formidability: This indicates the lack of personal skills for dealing effectively with the subject.
3) Self – determination: It includes the possession of positive and constructive attitudes in our personal plans and goals.
4) Social Relations: It means the tendency to participate in variety of activities and keep friendly relationship relating to others.

Phase – III – Experts Opinion and Evaluation of Items:
In order to establish whether a given item really belongs to that particular dimension, the items were arranged in a random order and subjected to expert scrutiny.
The experts were drawn, from the field of education, college teachers etc.

To facilitate the experts in judging the items, they were presented with expressional definition of dimensions.

They are requested,

a) To indicate whether the items were clearly stated and easily understood by the Higher Secondary Students of Science Stream.

b) To suggest necessary modifications, if any.

The lists of items were translated by the investigator into Gujarati.

Then the lists of items were given to the language expert with a request to examine vocabulary level, syntax and meaning. The modifications and improvements suggested were carried out wherever necessary in order to ensure the clarity of items in Gujarati Version.

The items of the Scale had five categories of responses. They were

1. Strongly agree
2. Agree
3. Undecided
4. Disagree
5. Strongly disagree

Pilot Study:

All the accepted items for the scale were arranged in a random and administered to a sample of 30 students. Proper instructions were given before the administration of the tool. The subjects were asked to answer all the items and no time limit was imposed.

Phase IV Finalization of the Tool:

Necessary modifications were made following the observations of the pilot study. At the end of this process a final version of attitude scale was made available which consisted a final draft of 60 statements.

Reliability:

Reliability is the consistency of a good tool, yielding some results in measuring whatever it does measure. In other words it proposes to measure the particular trait when applied at different parts of the time.

Before the actual collection of the data, the instrument was pre-tested with 30 students who are not included in the sample group, but who study in higher secondary school of science stream.
To check the reliability, the result was analyzed by means of Croanbach’s Alpha-Coefficient.

\[
\alpha = \frac{n}{n - 1} \left(1 - \frac{\sum S^2_i}{S^2_t}\right)
\]

Where \(\alpha\) = Coefficient of reliability
\(n\) = Number of items on the scale
\(\sum S^2_i\) = The sum of variance of each item
\(S^2_t\) = The variance of the scale

The result of the reliability test (alpha) was 0.96.

Thus for finding out the reliability coefficient split half method was used. Reliability was also established in present study by split - half method and the reliability Co-efficient were found to be 0.96. It’s seen that their value was highly significant and the result of the test was relied up.

**Validity:**

Validity means truthfulness of the test. This means the test measures the attainment of objectives for which it is designed. The Intrinsic validity was established by taking the square root of reliability co-efficient. Thus from the two co-efficient it may be inferred that this tool is reliable and highly valid.

To validate the content validity of the instrument, it was sent to the experts to review the items for the improvement to have the content as in the conceptual framework.

The attitude scale was prepared of sixty two statements to study the attitude of students of science stream of higher secondary schools towards opting Mathematics group. Thirty three statements were positive out of sixty two statements and twenty nine statements were of negative nature.

Thus the primary version of attitude scale of sixty two statements was made ready to measure the attitude of the students of science stream of higher secondary schools of Gujarat. At the initial stage there were 62 items in the scale but two items were omitted as they were irrelevant and four items were modified in their language.
Thus the final version contains 60 items in all. The item-10 and 47 of the primary scale were rejected and item-6, 8, 19, 38 of the primary scale were modified. The primary and final versions of Attitude Scale are appended in appendix with its scoring key. The blue print of the attitude scale is represented in the table 3.1 and the statements whether they are accepted, rejected or modified are shown in the table3.2.

TABLE-3.1
THE BLUE PRINT OF ATTITUDE SCALE

<table>
<thead>
<tr>
<th>THE NATURE OF ITEM NUMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive statements</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>1, 2, 5, 6, 9, 10, 11, 17, 19, 20, 21, 24, 26, 27, 28, 32, 33, 34, 38, 39, 40, 44, 45, 46, 47, 51, 52, 53, 56, 57, 59, 61, 62</td>
</tr>
<tr>
<td>Total Statements</td>
</tr>
</tbody>
</table>

TABLE - 3.2

THE STATEMENTS OF THE ATTITUDE SCALE
1. I opt for Mathematics group because good guidance is provided in these subjects.  

   **Accepted**  Rejected  Modified

2. I opt for Mathematics group because experienced teachers teach these subjects.  

   **Accepted**  Rejected  Modified

3. I do not opt for Mathematics group because it requires more practice and hard work.  

   **Accepted**  Rejected  Modified

4. I do not opt for Mathematics group because it is boring to do sums.  

   **Accepted**  Rejected  Modified

5. I opt for Mathematics group because I am interested in Mathematics.  

   **Accepted**  Rejected  Modified
6. I opt for Mathematics group because the subjects in this group are easy.

Accepted    Rejected    Modified as

I opt for Mathematics group because the subjects in this group are easy to learn.

7. I do not opt for Mathematics group because it is very difficult to pass in mathematics.

Accepted    Rejected    Modified

8. I do not opt for Mathematics group because the students can hardly pass in these subjects.

Accepted    Rejected    Modified as

I do not opt for Mathematics group because the results of these subjects are very low.

9. I opt for Mathematics group because I can more marks in Mathematics than other subjects.

Accepted    Rejected    Modified
<table>
<thead>
<tr>
<th>Number</th>
<th>Statement</th>
<th>Accepted</th>
<th>Rejected</th>
<th>Modified</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.</td>
<td>I opt for Mathematics group because my school has facility of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>comfortable classroom for these subjects.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accepted</td>
<td>Rejected</td>
<td>Modified</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>I opt for Mathematics group because my school has enough</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>physical resources for these subjects.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accepted</td>
<td>Rejected</td>
<td>Modified</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>I do not opt for Mathematics group because tuition fees</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>of mathematics are very high.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accepted</td>
<td>Rejected</td>
<td>Modified</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>I do not opt for Mathematics group because teachers do not</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>teach well in these subjects.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accepted</td>
<td>Rejected</td>
<td>Modified</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>I do not opt for Mathematics group because the qualified teachers are not available in my school.</td>
<td>Accepted</td>
<td>Rejected</td>
<td>Modified</td>
</tr>
<tr>
<td>15.</td>
<td>I do not opt for Mathematics group because the course of mathematics is very lengthy.</td>
<td>Accepted</td>
<td>Rejected</td>
<td>Modified</td>
</tr>
<tr>
<td>16.</td>
<td>I do not opt for Mathematics group because the basic concepts and processes are not understood.</td>
<td>Accepted</td>
<td>Rejected</td>
<td>Modified</td>
</tr>
<tr>
<td>17.</td>
<td>I opt for Mathematics group because it is possible to get good job with the knowledge of these subjects.</td>
<td>Accepted</td>
<td>Rejected</td>
<td>Modified</td>
</tr>
<tr>
<td>18.</td>
<td>I do not opt for Mathematics group because my family wants me to become a doctor.</td>
<td>Accepted</td>
<td>Rejected</td>
<td>Modified</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>19.</strong></td>
<td>I opt for Mathematics group because my family wants me to become an engineer.</td>
<td><strong>Accepted</strong></td>
<td><strong>Rejected</strong></td>
<td><strong>Modified</strong> as I opt for Mathematics group because my family insists me to become an engineer.</td>
</tr>
<tr>
<td><strong>20.</strong></td>
<td>I opt for Mathematics group because other groups are expensive to study.</td>
<td><strong>Accepted</strong></td>
<td><strong>Rejected</strong></td>
<td><strong>Modified</strong></td>
</tr>
<tr>
<td><strong>21.</strong></td>
<td>I opt for Mathematics group because it is prestigious in the society.</td>
<td><strong>Accepted</strong></td>
<td><strong>Rejected</strong></td>
<td><strong>Modified</strong></td>
</tr>
<tr>
<td><strong>22.</strong></td>
<td>I do not opt for Mathematics group because the study of mathematics is not useful in life.</td>
<td><strong>Accepted</strong></td>
<td><strong>Rejected</strong></td>
<td><strong>Modified</strong></td>
</tr>
<tr>
<td><strong>23.</strong></td>
<td>I do not opt for Mathematics group because it gives mechanical and boring experiences.</td>
<td><strong>Accepted</strong></td>
<td><strong>Rejected</strong></td>
<td><strong>Modified</strong></td>
</tr>
<tr>
<td>No.</td>
<td>Statement</td>
<td>Accepted</td>
<td>Rejected</td>
<td>Modified</td>
</tr>
<tr>
<td>-----</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td>24.</td>
<td>I opt for Mathematics group because it is possible to get admission in college even with low number of marks.</td>
<td>Accepted</td>
<td>Rejected</td>
<td>Modified</td>
</tr>
<tr>
<td>25.</td>
<td>I do not opt for Mathematics group because I like laboratory work more than doing sums.</td>
<td>Accepted</td>
<td>Rejected</td>
<td>Modified</td>
</tr>
<tr>
<td>26.</td>
<td>I opt for Mathematics group because my brother/sister has also opted this group.</td>
<td>Accepted</td>
<td>Rejected</td>
<td>Modified</td>
</tr>
<tr>
<td>27.</td>
<td>I opt for Mathematics group because I feel comfortable in this subject.</td>
<td>Accepted</td>
<td>Rejected</td>
<td>Modified</td>
</tr>
<tr>
<td>28.</td>
<td>I opt for Mathematics group because the school has enough resources.</td>
<td>Accepted</td>
<td>Rejected</td>
<td>Modified</td>
</tr>
<tr>
<td>No.</td>
<td>Statement</td>
<td>Accepted</td>
<td>Rejected</td>
<td>Modified</td>
</tr>
<tr>
<td>-----</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td>29.</td>
<td>I do not opt for Mathematics group because mathematics does not give pleasant learning experiences.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.</td>
<td>I do not opt for Mathematics group because it is not useful for medical education.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31.</td>
<td>I do not opt for Mathematics group because I cannot understand mathematics just by reading.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32.</td>
<td>I opt for Mathematics group because the school has a conducive teaching learning environment.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33.</td>
<td>I opt for Mathematics group because my brother/sister failed in the subjects other than Mathematics group.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>34.</strong> I opt for Mathematics group because it is my parents wish.</td>
<td><strong>Accepted</strong></td>
<td><strong>Rejected</strong></td>
<td><strong>Modified</strong></td>
<td></td>
</tr>
<tr>
<td><strong>35.</strong> I do not opt for Mathematics group because my parents can not help me in my homework.</td>
<td><strong>Accepted</strong></td>
<td><strong>Rejected</strong></td>
<td><strong>Modified</strong></td>
<td></td>
</tr>
<tr>
<td><strong>36.</strong> I do not opt for Mathematics group because it requires more to study.</td>
<td><strong>Accepted</strong></td>
<td><strong>Rejected</strong></td>
<td><strong>Modified</strong></td>
<td></td>
</tr>
<tr>
<td><strong>37.</strong> I do not opt for Mathematics group because teachers say. that mathematics is a difficult subject.</td>
<td><strong>Accepted</strong></td>
<td><strong>Rejected</strong></td>
<td><strong>Modified</strong></td>
<td></td>
</tr>
</tbody>
</table>
38. I opt for Mathematics group because these subjects do not require extra tutions.

Accepted     Rejected     Modified as

I opt for Mathematics group because these subjects do not require tutions.

39. I opt for Mathematics group because I am capable of performing well.

Accepted     Rejected     Modified

40. I opt for Mathematics group because the school has positive learning atmosphere.

Accepted     Rejected     Modified

41. I do not opt for Mathematics group because it is no more important in human life.

Accepted     Rejected     Modified

42. I do not opt for Mathematics group because I do not understand mathematics from my childhood.
<table>
<thead>
<tr>
<th>Accepted</th>
<th>Rejected</th>
<th>Modified</th>
</tr>
</thead>
<tbody>
<tr>
<td>43. I do not opt for Mathematics group because Biology is easier than Mathematics.</td>
<td>Accepted</td>
<td>Rejected</td>
</tr>
<tr>
<td>44. I opt for Mathematics group because the school provides standard study materials, tools etc.</td>
<td>Accepted</td>
<td>Rejected</td>
</tr>
<tr>
<td>45. I opt for Mathematics group because the opportunities to get admission in interesting domains are rare in other subject groups.</td>
<td>Accepted</td>
<td>Rejected</td>
</tr>
<tr>
<td>46. I opt for Mathematics group because there is no other option.</td>
<td>Accepted</td>
<td>Rejected</td>
</tr>
<tr>
<td>47. I opt for Mathematics group because I do not like it.</td>
<td>Accepted</td>
<td>Rejected</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>48. I do not opt for Mathematics group because it is not useful in higher education.</td>
<td><strong>Accepted</strong></td>
<td>Rejected</td>
</tr>
<tr>
<td>49. I do not opt for Mathematics group because I want to become a scientist.</td>
<td><strong>Accepted</strong></td>
<td>Rejected</td>
</tr>
<tr>
<td>50. I do not opt for Mathematics group because Mathematics gives unnecessary burden to a student.</td>
<td><strong>Accepted</strong></td>
<td>Rejected</td>
</tr>
<tr>
<td>51. I opt for Mathematics group because the syllabus of these subjects is shorter than those of other groups.</td>
<td><strong>Accepted</strong></td>
<td>Rejected</td>
</tr>
<tr>
<td>52. I opt for Mathematics group because my parents hold higher position in these subjects.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Statement</td>
<td>Accepted</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>53</td>
<td>I opt for Mathematics group because I feel pride to study these subjects.</td>
<td>Accepted</td>
</tr>
<tr>
<td>54</td>
<td>I do not opt for Mathematics group because it does not effect my success in higher education.</td>
<td>Accepted</td>
</tr>
<tr>
<td>55</td>
<td>I do not opt for Mathematics group because it obstructs my learning of other subjects.</td>
<td>Accepted</td>
</tr>
<tr>
<td>56</td>
<td>I opt for Mathematics group because it does not need to read more.</td>
<td>Accepted</td>
</tr>
</tbody>
</table>
57. I opt for Mathematics group because there is less practical work.

Accepted   Rejected   Modified

58. I do not opt for Mathematics group because it brings inertia in a student.

Accepted   Rejected   Modified

59. I opt for Mathematics group because Mathematicians are highly respected in the society.

Accepted   Rejected   Modified

60. I do not opt for Mathematics group because teachers say that mathematics is a difficult subject.

Accepted   Rejected   Modified

61. I opt for Mathematics group because I may get more job opportunities in abroad.

Accepted   Rejected   Modified
62. I opt for Mathematics group because I have no interest in Biology.

<table>
<thead>
<tr>
<th>Accepted</th>
<th>Rejected</th>
<th>Modified</th>
</tr>
</thead>
</table>

3.3.2 SCORING KEY

The method of using the scale is simple. The user can use the scale as it is appended in appendix with its scoring key. The students should be asked to give their responses to each statement. There are sixty two statements in this scale.

The responses of the students were given proper weightage by the scheme of scoring. The scheme of giving weightage to each statement is shown in the table 3.3
### TABLE- 3.3
WEIGHTAGE TO THE STATEMENTS

<table>
<thead>
<tr>
<th>Type of Statement</th>
<th>Weightage given to the response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly agree</td>
</tr>
<tr>
<td>Favourable</td>
<td>4</td>
</tr>
<tr>
<td>Unfavourable</td>
<td>0</td>
</tr>
</tbody>
</table>
There are sixty statements in this scale. Maximum weightage to each statement is four. So, the maximum score of the scale would be 240. The neutral value of each statement two, so neutral value of the scale would be 120. If the test user finds total score of a student more than 120, it shows the positive attitude of a student. If he finds total score of a student less than 120, it shows the negative attitude of a student.

3.3.3 SCALE NORMS

The scale has been administered to the sample selected by the investigator. The investigator asked the students to write in the space given in part-1 of the scale. The details were as follow:

1) Name of the school
2) Address of the school
3) Name of student
4) Standard
5) Subject Group
6) Sex
7) Category
8) Result of Mathematics in S.S.C.E

The Attitude Scale is meant for students of higher secondary schools of science stream in Gujarat.

2.4 SELECTION OF THE SAMPLE

3.4.1. POPULATION AND SAMPLE

For selection of the sample, the researcher must know the population of his study. When an investigator is well aware of his research problem, he is well aware of his population too. Population is all members of the subject on which the researcher wants to study. Population may be comprised of people, objects or items. Population includes each and every member of the target group of the study. But it not possible for an investigator to collect information from each and every member of the target group under study. The process of data collection will become very lengthy and time consuming. In some cases, the situation or phenomenon may have changed till the completion of the study. So selection of representative sample is advisable in research
studies. Sample is a small representative group selected from the population. It is a subset of the whole population.

Sometimes the population may become sample when population is obvious. To study the effectiveness of teachers in any one school, the population can be sample for the study. All the teachers of that school will form population of the study and all teachers of that school will form the sample. The population may even comprise of objects, time, space or combination of other dimensions. When cause and effect is to be studied, the population is in the form of non tangible outcome. In such situation, the investigator treats the observed population as his sample. Sometimes it may happen that population of research is different from the population from which the sample has been drawn. For instance to study about the health of human beings, the researcher works on the sample taken from some animals. Selection of population and sample is the most important stage of the research procedure.

In this way we define population as a group including all members for whom the researcher wants to apply his findings. If someone wants to study the attitude towards opting mathematics of the higher secondary students of science stream in Gujarat, the population would be all the higher secondary school students studying in science stream in the schools of Gujarat. The data collected from the population have some parameters to be described. The number of subjects in a population is labeled with an upper case \( N \) (\( N=400000 \)).

### 3.4.2 SAMPLING TECHNIQUE

Population in research study may vast and out of control to be accessed and assessed. It is not possible for an investigator to collect data from each and every member of the population. Suppose, if someone wants to know the views of the students about their examination system, he will not be able to collect information from all the students in this world. If the objective of the study is confined to some particular country, still again it will be more difficult to get data from each student of the country. Moreover, it will be more time consuming and costly for an investigator. To get rid of this problem, the researcher studies only the small part or the subset of the population of the study. Actually a sample represents the wider and vast population of the study. Sampling is technique which is most commonly used in the research studies in the branches of humanity for collecting data and finding the
conclusions. Sampling is a very useful technique to find the solution of the problem for the entire population without studying the whole population.

Thus sampling is a technique to test some selected members or objects the population and the results are applied to the whole population. As any housewife can test some of the grains of the food being cooked and know that all grains have been cooked, the researcher also tests some selected members or objects. Just testing a sip of tea, the quality of tea can be judged, looking at some of the grains from a wheat bag judgment can be passed for the whole bag of wheat and some soil of the moon may help the scientists to know about the characteristics and history of formation of the moon. In the same way, the investigator can know about the whole population of his study by just testing some of the members of the population. Thus selection of some of the members or objects from the population for the purpose of testing is known as sampling technique.

Sampling is an important stage in the process of research study where testing a part, an investigator infers about the whole. The investigator tests some of the units of the whole to get statistical data. The process of sampling should be so scientific that it may reduce threats in applying the results of part to the whole. Sometimes when the sample not a representative sample, the results may not be applicable to the whole population. So selection of sample in a proper way is necessary for an investigator. There are some methods of sampling which helps an investigator to reduce the threats against the reliability and validity of the results, in applying them to the whole population. The classification of the sampling techniques is shown in the following Figure-3.17.
Figure-3.17
Sampling Methods:

Classification of Sampling Methods

- **Sampling methods**
  - **Probability sampling**
    - Simple random sampling
    - Stratified sampling
    - **Cluster Sampling**
      - Simple cluster sampling
      - Systematic sampling
  - **Nonprobability sampling**
    - **Judgment sampling**
    - **Convenience sampling**
    - **Quota sampling**
There are some sampling methods or techniques which helps the researcher to select the sample of his study in an appropriate way. All sampling methods can be classified into two major groups namely probability sampling and non probability sampling. Probability Sampling can be sampling with equal probabilities or sampling with unequal probabilities and Non probability sampling is sampling without probabilities.

Probability Sampling:

A probability sampling is a technique of selecting a sample of the study randomly. This type of sampling method uses random selection of the items or units from the entire population. For random selection also the investigator should have some scheme or procedure to be adopted so that all units or elements of the population have equal opportunity to be selected. Drawing system is the best example of random selection. An investigator may have random selection by numbering the items of the population and selecting odd numbers, even numbers or any blind numbers from the list of the elements in the population. For getting random numbers, we have many computerized technique developed for the purpose of research studies. Simple random sampling, Stratified random sampling, Systematic random sampling, Cluster or area random sampling and Multi stage sampling are some of the sampling methods which fall under the type of probability sampling.

Equal Probability Sampling and Unequal Probability Sampling:

The equal probability sampling methods like a simple random sampling or systematic sampling methods are not so useful when units or members of the population are diversified in their size. When there is considerably high variability in size of the items, equal probability sampling techniques do not seem to be so productive regarding a good estimate of the sample. Here the investigator should give more probability to bigger items of the population. Thus the probability of selection becomes unequal. When the investigator considers the choice of sampling units, stratification, multi stage or multi phase selection of sampling units, the probability of all of elements of the population to be selected in the sample becomes unequal.

Non Probability Sampling:

This is a sampling technique where each and every member of the population does not get equal opportunity to be selected in the sample so it is non probability sampling technique. The main difference between probability and non probability sampling is that probability sampling techniques adopt randomization of selection
while non probability sampling techniques do not adopt randomization of selection. Sometimes it is believed that non probability sampling cannot produce representative sample. But it is not so. Non probability sampling is not dependent on the theory of probability and of course, it is difficult for an investigator to know the confidence intervals for statistics. In probability sampling, an investigator is sure about representation of the population and he is able estimate the confidence intervals for the statistics. So the researchers, most commonly like to adopt probability sampling methods instead of non probability sampling methods. But in social sciences, working with some target groups, probability sampling is not possible or feasible; it becomes imperative for an investigator to adopt non probability sampling methods. Non probability sampling methods are broadly divided into two major groups namely accidental and purposive. Accidental type of sampling is haphazard or convenience sampling. When selection of the sample is made according to some plan or purpose of the study, the selection becomes purposive. Some commonly used techniques include convenient sampling, purposive or judgmental sampling, snow ball sampling and quota sampling.

Some most commonly used and discussed methods are described here.

1. Simple Random Sampling:
   Simple random sampling method is most commonly used method in research studies. It is an equal probability method because each and every unit or member of the population has equal opportunity to be selected in the sample. Using numbers randomly, the researcher can make the selection of the units for his sample. In this sampling method, every member of the population is given a number and then randomly some numbers are drawn or selected for the sample. Here the principle of chance is applied to every unit, object or member of the population. For example, there are thousand students in a population and fifty students are to be selected in the sample, investigator will number the students from 1 to 1000 without repeating any number and select any fifty numbers randomly. Thus the students having randomly selected fifty numbers will constitute the sample of the study for an investigator.

2. Systematic Sampling:
   In simple random sampling method, the chance of polarization of the units may occur. To avoid this drawback, systematic sampling method is useful. Here in this method also all the members or units of the population are given one unique number but they are not selected randomly to be included in the sample of the study. Instead,
they are selected by generating number from the intervals derived by dividing N by n. For example, there are thousand students in the population and fifty students are to be selected for the sample; first of all, the investigator will give one unique number to each member or unit of the population, then he will divide N by n, here he will divide 1000/50, so the intervals will be found after each 20 number interval. Out of these intervals, the investigator will generate one number following some scheme, that is to say he can select the first number from each interval or he may select the last number of each interval or any of the specific numbered number from every interval following uniformed scheme or system. Each number of each interval has an equal chance to be selected so this method is also called a sampling technique with equal probabilities. In this way, the numbers selected for the sample will be every spread of the population and not from the polarized data. From the entire population, an investigator can select the evenly distributed sample using systematic sampling method.

3. Stratified Sampling:

Stratified sampling is a technique where an investigator selects the items for his sample from the divisions or groups of the population which are already made according to their specificity. In this method of sampling, the entire group of the population is classified in some small sub groups or strata. The investigator selects the items from each group proportionate to its size. Stratified sampling technique helps the investigator to highlight the characteristic of a particular sub group. Suppose; the investigator wants to study the attitude of the higher secondary students towards mathematics in Gujarat. So the population for this study will be all higher secondary students of the schools in Gujarat. Now Gujarat is a state which is divided into districts that are not the same in size. So naturally the number of higher secondary schools in each district will vary. Hence first of all, the investigator will divide the higher secondary schools according to their districts. Then in proportion to the number of students in each district, the researcher will select the students for his sample. If the district is big having more number of higher secondary schools, the number of higher secondary students may be more than the others. So the researcher will select more number of students from this district in comparison to others. This method of sampling is helpful to the investigator in selecting representative sample comprising of adequate number of members from each sub group of the entire population.

4. Cluster Sampling:
Cluster sampling is a technique where the investigator selects one cluster or group from each subgroup of the entire population. Like stratified sampling method, here also the whole population is divided into sub groups, but instead of selecting items from each group in proportion to its size, the investigator selects the whole cluster from each sub group. For example, if someone wants to study the attitude of higher secondary students towards mathematics in Gujarat, all higher secondary students of the schools in Gujarat will be the entire population for his study. The investigator will divide the entire population into the sub groups namely districts of the state. Now instead of selecting the students in proportion to number of the students in each district, he will randomly select some higher secondary schools, no matter from which district or how many number of the students are there. Sometimes, it is not possible for an investigator make an exhaustive list of all the members of the population, he can select some clusters randomly and include all members or elements of the cluster in his sample at first stage or at second stage he may again make a random selection of the elements according his need of the numbers of items or members to be included in his sample. This type of sampling technique is economical regarding cost, time and effort on the part of an investigator.

5. Convenience Sampling:

Convenience sampling is based on reliance on a available elements or units of the sample. The investigator selects any member of the population that he finds available, just as he stops any person passing there and gets the information. In this way the researcher cannot get a representative sample. This method is very risky and not much reliable so the results of such study may not be applied to the entire population for generalization.

6. Purposive Sampling:

A purposive sampling technique is also known as judgmental sampling. Here the investigator selects the items according to his knowledge of the population and objectives of his study. The selection of the sample is based on the purpose of the study so it is called purposive sampling technique. If the researcher wants to study the factors affecting students’ best performance in the examination, he will select only the students who performed best in the examination. Students with middle or poor performance will not be included in the sample. Mostly this type of sampling technique is required when the researcher wants to highlight variables covered under study.
7. Snowball Sampling:

When it is very difficult for an investigator to find the members of the population, snowball sampling method is useful. In the field of sociology, often studies on sex workers, migrants, illegal immigrants, homeless beggars, acute patients and so on face the challenges in selection of the sample for the study. So starts his study collecting data with the few members available but as he goes on finding more members of the population, he goes on adding them in his sample. As making a snowball, in the beginning one takes some amount of snow but he goes on adding the snow making the ball bigger. Just in the same way, the investigator goes on adding the elements or units of the population into his sample of the study. Here, the researcher tries to get information from the member of the target population not only for his study but also about other members of the population. If the researcher wants to know about the illegal immigrants, he will collect data from the few immigrants that he found available and he will also try to know about other such immigrants. So in this type of sampling technique, the process of selecting sample is not time bound, but it rather continues till the researcher can get sufficient sample for his study.

8. Quota Sampling:

In the quota sampling technique, the investigator selects the members from the population on the bases of predetermined variables. If the researcher wants to study the traits of teenager students, he will determine the variables to be covered in the study. The variables like gender, their socioeconomic status, family background and many other variables may affect the traits of teenagers but the researcher will select the members of the population according to the variables covered under his study and in a proportion to the size of the sample predefined by him.

For the present study, the investigator adopted a stratified random sampling method for selecting his sample for the study. To have as big a sample as one can, is desirable for better norms. But the representative sample should not be too large. Representative sample should be carefully determined. There are methods of sampling procedure. For the present study the stratified random sampling method has been adopted.

According to Garrett, Stratified random sampling is a technique designed to ensure representativeness and avoid bias by use of a modified random sampling method. According to this idea of sampling by stratification it was decided to
administer scale in practically all the parts of Gujarat state. This stratification is relatively homogenous for common spoken language is Gujarati; hence, sampling within the strata was random so that every individual in the strata had equal chance of being chosen. The following variables were considered at the time of selecting the sample.

1. Class-XI and Class-XII
2. Category- Reserved and Non-reserved
3. Sex- Male, Female
4. Area- Rural and Urban where the school is situated.
5. Achievement- below 60 % and with 60 % or above 60 % achievements

For the selection of the representative sample, the investigator had decided to cover most of the parts of Gujarat state.

### 3.4.2 SAMPLE SIZE

It is always a matter of confusion for an investigator to decide about the size of the sample for his study. It is important to select sample in adequate size for the purpose of statistical applications and get reliable results to be applied to the entire population. An instigator studies the sample and makes inferences about the population. Thus the sample size depends on sufficient data required for the statistical analysis and interpretations. The size of a sample may differ according to the research method adopted for the study by an investigator. The size of a sample may also differ according to the population selected for research study. As for example, in any kind of survey research, the investigator chooses stratified random sampling method for the selection of his sample of the study, the size of sample will differ in accordance to the population of the study. The sample size should correspond to the population size. In the same way, the experimental research requires the sample according to the experimental design adopted for the study by an investigator. If it is a two equivalent group design, the investigator will need two groups of same size. If it is a factorial design covering more variables under study, the investigator will need more groups of the same size in accordance with the variables in the study. Thus, the size of a sample differs according to the type of research method, nature and size of population, objectives of the study and need of statistical applications adopted for the research study. Thus while determining the size of a sample; an investigator should keep in
mind the several aspects such as the objectives of the study, size of the population, sampling error, the level of confidence and so on.

Formula for proportion:

\[ n_0 = \frac{z^2 \cdot p \cdot (1 - p)}{e^2} \]

- \( n_0 \) – the size of the sample
- \( z^2 \) - Normal curve abscissa
- \( e \) - the acceptable error of sampling
- \( p \) – the estimated population

Finite population correction for proportions

\[ n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}} \]

- \( n_0 \) - the initial sample size
- \( n \) - adjusted sample size
- \( N \) - the population size.

Simplified formula for proportions:
(Taro Yamane)

\[ n = \frac{N}{1 + N \cdot e^2} \]

- \( n \) - the sample size
- \( N \) - the population size
- \( e \) - the acceptable sampling error

* 95% confidence level and
\( p = 0.5 \) are assumed
For the present study, the total population of the students of science stream of higher secondary schools is about 234000 as per the data available. The researcher has used stratified random sampling and to select the sample, the formula of Taro Yamane (1967) has been used as shown below.

Formula

\[ n = \frac{N}{1 + Ne^2} \]

Where

- \( n \) = size of sample group
- \( N \) = size of population
- \( e \) = the miss adjusting rate in random sampling at level 0.05

\[ n = \frac{234000}{1 + (234000(0.05)^2)} \]

\[ = 399.31 \]

\[ = 399 \]

Therefore, the sample size as per the formula will be 399 students of science stream of higher secondary schools of Gujarat. Among these students, about 25% students were of English medium schools. So the researcher decided to select 300 students considering the independent variables covered under the study.

The table 3.4 shows the class-wise, category-wise, sex-wise, area-wise and achievement-wise distribution of the sample selected for the study.
<table>
<thead>
<tr>
<th>No.</th>
<th>Name of Variable</th>
<th>Name of Levels</th>
<th>Number of Students</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Class</td>
<td>Class-XI</td>
<td>150</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Class-XII</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Category</td>
<td>Reserved</td>
<td>100</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-reserved</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Sex</td>
<td>Male</td>
<td>150</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Area</td>
<td>Rural</td>
<td>150</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Urban</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Achievement</td>
<td>below 60 %</td>
<td>150</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60 % or above 60 %</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td><strong>300</strong></td>
</tr>
</tbody>
</table>
Considering all the factors viz., instruction in general, explanation for the practice item, time duration etc. for complete responses, the attitude scale was administered to the representative sample of students selected as shown in table. 3.4

The testing programme commenced from Aug. 2013 and it lasted up to Dec. 2013. The investigator had practically no difficulty in getting the co-operation during the testing programme from heads of the higher secondary schools and students.

3.5 DATA COLLECTION

Collecting information from the members selected in the sample required for the study is known as data collection. It is an important part of the whole research process. Collection of data in an appropriate way or inappropriate way influences directly on the results of the study. Accurate data collection contributes to the validity of the results of the study.

Thus data collection is a very important stage in the procedure of research study. Gathering reliable and valid information from the respondents demands utmost accuracy and carefulness on the part of an investigator, so planning of data collection should be done very thoughtfully and minutely. To collect the data regarding variables to be measured for the study is the key of the doors of the truth to be explored. It is this process which enables the researcher to seek the answers of his research questions, leads him to test the hypotheses of his research problem and
evaluate the results of his research study. Hence data collection is common yet very important in any kind research studies in any field of knowledge whether it is physical sciences, social sciences, humanities, business or technology. However, research study may be of any discipline of knowledge, there should accuracy and honesty on the part of an investigator while collecting data for his research study. Any data collector should aim at gathering quality information to be translated into quality data analysis to derive the valid and reliable conclusions which can provide credible answers to his research questions and provide effective solutions to his research problem.

Thus, data collection is not concerned with the field of knowledge or the nature of information; it is only concerned with accuracy in the process. It is also necessary for an investigator to maintain consistency and integrity with data and goals of the research study. But only the accuracy and honesty on the part of investigator will not serve purpose of the research study. His accuracy, honesty and thoughtfulness is required in selection of the instrument to collect data as well as it is required in administrating the instrument. He appropriateness of the instrument for the study will be helpful to an investigator to collect valid and reliable data for his research. The instrument may be ready made or modified according to needs of his research study or it is self constructed, the investigator should strictly follow the instructions for an instrument to be used. Administrating the instrument following the instructions in the manual will be useful to the investigator in reducing errors and gathering quality data. So it is necessary for the data collection process to be more formal and scientific. Otherwise, inappropriate data collection will not enable the researcher to have the valid outcomes of his research study. However, the influence of incorrect data collection may not be the same in every discipline of the study. It may differ according to the discipline of the study and also to the nature of the research problem. The faulty data collection can be the most harmful when the results of the study are applied to policy making by the authorities. So it is most imperative for an investigator to be careful regarding data collection throughout the process.

Thus data collection is the most important process of gathering quality, reliable and valid information required for the study. The information provided by the elements of the sample can be of two types namely qualitative or quantitative. The very nature of information leads us to decide whether the data are qualitative or quantitative.
When collected data can be applied to the statistical techniques, it is said that the data are quantitative in nature but when data are not eligible for applying directly to the statistical processes, it is said that data are qualitative in nature. Accordingly, data collection methods are also divided into two major groups, that is to say, qualitative data collection methods and quantitative data collection methods.

Quantitative Data Collection Methods:

Quantitative data collection methods are supportive to statistical processes. Such methods require randomization in sampling techniques and a standard instrument for collecting such data which can be easily calculated and analyzed using statistical techniques and fit to conclude the results which can be easily summarized, compared and generalized. In quantitative research study, an investigator formulates the hypotheses based on the assumed results of the study, and using the collected data, he tests the hypotheses to find the results of the study. The data here, are statistically controlled by the researcher.

Generally, quantitative data collection methods are used in experimental researches. Such data collection methods include conducting experiments, making clinical trials and recording observations of well defined events, finding relevant information using management information services and conducting surveys using techniques like interviews and questionnaires. Interviews and questionnaires are two most commonly used strategies of quantitative data collection.

Interviews: In researches like surveys, interviews are also very formal and pre planned. Interviews are more structured in quantitative researches unlike interviews in qualitative researches. As Leedy and Ormrod (2001) said an investigator is not allowed to ask anything else except the scheduled list of questions set previously in a structured type of interview. Such structured interviews are conducted in three ways, they can be face to face interviews, telephonic interviews or personal interviews assisted by the computer.

1. Face to Face Interviews: Face to face interview is more lively and advantageous than telephonic or computer assisted interviews. Here the interviewer and interviewee are face to face so the interviewer can establish a good rapport with the respondent and find his or her cooperation in providing the information required for the research study. In survey type researches, face to face interview technique of data collection is most commonly used. Here the researcher may have a chance to clarify his question, help the respondent in confusion and notice the facial gestures of the respondent while
replying the question. Thus face to face interviews are more advantageous than other techniques of collecting data but this technique is feasible only when the sample is small, otherwise, it can be proved to be very costly and time consuming when sample is large and scattered.

2. Telephonic Interviews: Telephonic interviews are more time saving and cheaper in comparison to face to face interviews. Telephone is a common and popular device of communication now a day. An investigator may contact any respondent if he or she has a device of telephone. The advantages that we find in face to face interview are not found in telephonic interview. The interviewer can only listens to the voice of the respondent, he cannot see him, so his facial gestures cannot be seen, but the interviewer can judge the tone of voice of the respondent. However, the video telephonic devices may solve this problem. This technique of data collection is not so advantageous as responses are not received so easily in telephonic interviews as they are found in face to face interviews. Yet this technique is more advantageous than mailed questionnaires. The sampling technique can be biased as the investigator can neither access the entire population nor he can add the members of the population without telephones into his sample.

3. Computer Assisted Interviews: Interviews assisted by the computer, generally known as CAPI (Computer Assisted Personal Interview) are just like face to face interviews but here the research notes down the responses in his laptop or personal handy computer like devices, instead of writing in a notebook. The computerized database can be prepared very easily and speedily by using the technique of computer assisted person interview. This technique is economical in the matter of time and advantageous for collecting valid and quality data for an investigator. Use of computer has become very common now a day so it is a desirable technique of collecting data for any research study but it can be proved to be expensive and specific skill oriented on the part of the investigator. The graphical presentation of types of interview is shown in Figure-3.16
Figure-3.18
Types of Interview

- Structured
  - Face-to-Face
  - Telephonic
  - Personal Interviews Assisted by Computers

- Unstructured
  - In Depth Interview
Questionnaires: A questionnaire is the most commonly used technique of collecting data for any kind of research study. Questionnaires can be paper-pencil questionnaires, web based questionnaires, checklists and rating scales.

1. Paper-pencil questionnaires: The questionnaires which are sent to the large number of respondents to be responded are known as paper-pencil questionnaires. The main advantage of this kind of data collection technique is that it is time economical in the matter of time and money. The responses of the respondents are more valid than the other methods of data collection, but all respondents do not send their responses to the researcher, can be a major disadvantage or limitation of this technique.

2. Web Based Questionnaires: The use of computer and internet in research work is very popular now a day. Computer and internet are the devices through which an investigator use some innovative technological methods and techniques of collecting data. An investigator may use email services or web sites for his questionnaire to be filled by the respondents. The main advantage of this type of technique of collecting data is that it is not much descriptive. The data necessary for the study can be easily and rapidly gathered using this technique. On the other hand the main limitation of this kind of data collection technique is that it is skill oriented. The respondents must have computer and he must also know to operate computer so all the members of the population may not have the equal chance to be selected in the sample of the study. If the respondents respond hurriedly, they might harm the validity of the results of the study. Yet this method is more convenient method of data collection in the present time.

3. Checklist and Rating Scales: Checklists and rating scales are also used as questionnaire devices for simplifying and quantifying the respondents’ attitude and behavior.

Checklist: A checklist is, as its name suggests, a list of items to be checked. The list here should be consistent and complete.

Rating Scale: A set of certain traits or categories form a research instrument called a rating scale. A ten point rating scale is very commonly used. A Likert type scale is also often used in surveys. It is an evaluative device which provides information
about some quality or attribute. The rating scale measures qualitative as well as quantitative attributes.

Qualitative Data Collection Methods:

In juxtaposition to quantitative data collection methods, qualitative data collection methods do not meant for statistical applications. When it is not possible to quantify data, the qualitative methods of data collection are useful. In many research studies in the field of sociology and anthropology, the qualitative data collection methods are used. When an investigator wants to study impact or influences, the qualitative methods of data collection are most desirable as they help the investigator to understand the processes and know about the changes taking place due to certain impact or influences. Sometimes surveys which generally adopt quantitative methods of data collection use qualitative data collection methods with a view to improving quantitative evaluations. Thus qualitative methods of data collection may help the researcher to support or justify his quantitative results.

The qualitative methods of data collection are characterized by their tendency to be open ended and no more structured in their form. The investigator is free to change or modify his strategy of collecting data for his research study. He is free to add or drop his units of population or techniques adopted by him. Instead of some structured forms, schedules or tests, an investigator here, uses natural observations and interviews as the most important techniques of data collection for his study.

An investigator has to involve in live and interactive observations and interviews more than once to gather valid and reliable information for his study. He continues his efforts until he gets satisfactory data to clarify the key concepts of the study. The follow up work is more important than just getting information. Thus getting information is not only the task of a researcher here, he also has to check the reliability of the information to have valid and reliable outcomes of the study. The term triangulation is the most important term in qualitative methods of collecting required data for the research study. The credibility of the results of the research study can be increased using the technique of triangulation in qualitative research methods of data collection. The technique of triangulation is involved in adopting multiple methods of data collection by the researcher. This technique of
triangulation enables the researcher to add authenticity to the results of the study. The qualitative methods of data collection cannot produce results that can be generalized for any specific population but they can provide some generalized patterns for each specific study. Qualitative methods of data collection are taking too much time as the investigator has to record the information achieved from the observations. Whether it is the technique of interview or observation, the objective and logical observation on the part of an investigator is the most important task to be accomplished by the investigator. For repeated observation and understanding the data in their truest form, the investigator needs the skill of taking notes very accurately and systematically, making sketches, recording audio and video evidences by using potential device without breaking the ethical rules of research.

The qualitative methods of data collection are of two types namely interviews, and observations. These methods are described here in detail.

1. Interviews: The technique of interview is used in quantitative researches too, but in qualitative research, this technique is quite different from structured interviews of quantitative research studies. Here the interviews are in depth interviews. In qualitative research, data collection and data analysis go hand in hand because the investigator has to validate the data every time he observes them. The in depth interviews are based on a conversation between an interviewer and a respondent but this conversation should be very confidential and secured.

Such an interview provides an investigator a deep insight into the respondent to evaluate specific nature, traits, characteristics or some specific material. This method is more useful when the respondents are sensitive in nature. It helps the investigator with the exploration of respondents’ emotional and unconscious realms.

In depth interviews are generally arranged in confidential places. They are arranged in such place where the investigator can find the respondent in his or her natural surroundings. Such places can be private home or some other peaceful place. The respondents should be relaxed to answer the questions of the researcher. The duration of in depth interviews should not be more than one or two hours. The interview should be recorded for the purpose of data analysis. The recorded data should be kept confidential and should be used only for the purpose of research.
only. After the research work is over, the collected data regarding personal interviews should be deleted and destroyed following the research ethics.

2. Observations: The most important method of data collection in qualitative research is observation as interviews also require observation on the part of an investigator. This technique is not so structured as experimental design and not so unstructured as the technique of in depth interviews. The observation techniques are of various kind but they can be divided into two major groups, namely direct and indirect observations.

Direct Observations:

Direct observations are the observations out of the laboratory. Instead they are sought in the natural surroundings of the respondents. Sometimes an investigator finds it unethical to put the respondents in the laboratory for the purpose of getting observations for his research study so he has to go to the respondents in their natural locations to get observations for his study. This type of observations is useful for an investigator when it is impossible for him to work in the laboratory. For example if the investigator wants to study the students’ verbal abuse while they quarrel or fight in the school, he cannot put the students in an artificial environment of the laboratory where they will be asked to quarrel or fight. Here the investigator has to go to the events of quarrel or fight whenever and wherever they occur in the school.

Direct observations can be observations with or without interventions. They can be participant observations or structured observation and field experiments.

1. Observation without Intervention: Observations without intervention are also known as naturalistic observation. If an investigator wants to collect information from the respondents keeping them in their natural environment, this technique of data collection will be more useful for him than any other technique. The investigator is able to study the natural behavior of the respondents using this method. This observation technique is quite opposite to observation of an experiment in the laboratory where an artificial environment is created for the purpose of obtaining observations to get necessary data for the research study. ‘Observations without interventions’ is a naturalistic technique of data collection so the investigator observes the members of his sample in their natural environment and settings where the respondents find themselves relaxed and free to behave
normally following their a routine chores. There are two ways of direct observations without intervention namely overt and covert. When the respondents are aware with the knowledge that they are being observed, that type of observation will be called overt observation; and when the respondents are not aware with the knowledge that they are being observed, that type of observation will be called covert observation. The direct observation without any intervention can be helpful to the investigator in verifying the external validity of his research study. Thus this type of technique can be used to support or justifying the findings of quantitative researches too. Sometimes the experimental research seems to be more expensive; this technique of direct natural observations can be useful to the researcher. Yet, this method of the direct naturalistic observations without any intervention has two main drawbacks. Firstly, the investigator cannot look into the causes of the observed situation. He can just describe the situations and cannot answer the question ‘why’ as he is not allowed to explain the observed situations. Secondly, it is purely unethical to observe anyone without his or her consent. If the investigator solves this problem by making the respondent aware of the fact that he is being observed or if he gets consent of the respondent, it is possible that the respondent may not behave in his natural way and this can affect the results of the research study. Besides this, the investigator has to wait for situations to occur and also he needs more than one observation, so this method becomes very slow and needs more time in comparison to any other method. Sometimes an investigator has to spend the whole day or many days after researching the situations to be observed for his study. The greatest danger in this type of observation is entering of subjectivity of the researcher into the observations. If the investigator judges the situations according to his likes and dislikes or with his sympathy or apathy about the situations, the results of the may not be reliable and valid.

2. Observation with intervention: Observations with some interventions are generally used by psychologists for their research studies. When the researcher wants to study the behavior or response of an individual some specific given settings instead of natural settings, he has to use the intervention ethos of observation with intervention. This is quite opposite to the naturalistic method of observation. The observation with intervention is useful when the investigator wants to study the situations that he can rarely find in normal natural settings. Here the researcher
observes the respondent directly but not in his natural environment. He observes the respondent with some intervention to study the responses of the respondents to some stimulus event. So that he can know the quality or effect of intervention. The investigator uses this method when scientific observation for the situation is not possible. Here in this method, the investigator has to control the effect of the respondents’ pre experiences by creating such condition which may provoke instant behaviours to be observed. The investigator manipulates the independent variable with a view to observing the effect of that variable on the behavior of the respondent. The direct observations with intervention can be conducted in three different ways namely, participant observation, structured observation and field experiments.

Participant Observation: In participant observation method, the researcher himself participates in the situation along with the respondent. The participation of the observer in the situation makes his observations more acute and realistic. Participant observations can be done in two ways namely disguised or undisguised ways. When an investigator wants to study about some religious or cultural behaviours of the people, he may participate with the people without disguising himself. But when it is possible for the respondents to change their behavior if they know about the participation of the researcher, it will be imperative for the investigator disguise himself. Thus the disguised observation method will be used by him. The investigator may participate in the religious ceremonies of festival celebration with the knowledge of his participation to the respondents, to study cultural trends or customs and this knowledge may not hamper the cooperation of the respondents. But involvement of students in some malpractices or antisocial activities cannot be observed by the investigator if his identity is not disguised because the knowledge of his participation will force the students involving in malpractices or antisocial activities to change their behavior. Hence, if the investigator get admission in the educational institution to participate with the group under observation and tries to know about their behaviors without their knowledge of his participation, that method will be called disguised observation method. Yet, from the view point of ethics in research, it will be against the human respect.

The method of participant observation is advantageous for an investigator as it helps him to study the behaviours of people in specific situations which cannot be
studied through scientific observations. Again, the investigator himself receives the same experiences as his respondents receive which enables him to understand the situations and behaviours very deeply and clearly. But eventually this advantage may become the limitation of this method. If the participant investigator is carried away with emotions and personal sentiments, the observations will be faulty and misleading. So an objectivity on the part of the investigator is a paramount requirement while using this method of observation. The interference of an investigator may also influence the behaviours of the respondents.

Structured Observation: In the participant observation, the researcher himself takes part in the situation but in structured observation he creates situation for the respondents to behave to provide him observations. It is a middle way strategy to participant observation and naturalistic observation as structured observations are used in natural surroundings as well as in scientific laboratory. The researchers studying in the field of clinical or developmental psychology prefer the method of structured observations. The investigator uses this method when it is difficult for him to record his observations in natural realistic settings and also it is difficult for him to record his observations in artificially controlled environment of any scientific laboratory. Thus creating the situation in natural settings and manipulating his independent variables, the investigator studies the behavioural patterns of his respondents. Here the control on independent variable is required, otherwise it will not be possible to get genuine observations.

Field Experiments: The method of field experiment is quite similar to the method of structured observations. In the structured observation, the investigator creates an artificial situation in the natural settings of the respondents manipulating one or more independent variables of his research study. Similarly in field experiment also, the investigator manipulates the independent variables in the natural situations but field experiments require the maximum control of the investigator on the variables. Thus the fundamental difference between these two types of observations is that of the degree of control of an investigator over the situation and in manipulation of the independent variables. Unlike naturalistic observations, field experiments permits the investigator to generalize his results.

Indirect Observations:
The data collection method of indirect observation is used when any of the direct observation method is not feasible to use for an investigator. When the investigator does not want to be noticed or recognized, he uses indirect method of observation. Sometimes it is unethical to observe certain behaviours or situations; to avoid such ethical problem, the investigator prefers to adopt indirect method of observation.

There are three common ways to observe the sample to collect evidences to derive at the results of the study. Indirect observations are made through physical trace evidences, archival records and document review.

1. Physical Trace Evidences: An investigator inquires about and studies the past events related to the respondents. He examines the past remnants which can be the items of two major types namely use and product. The traces of the first category display the use or nonuse of the items. Here the investigator can know whether the things or objects or items are used by the respondent or not. Fingerprints found on a telephone receiver, chocolate wrapper, glass of a wine or cigarette ends and many such objects are known as use traces. The traces of second category which are known as product traces are artificially created traces. Paintings, songs, dances and so on fall in the category of product traces. Use traces are helpful for an investigator to gather information about the behaviors of the respondent while product traces are useful to know about the culture of the present time. The method of observation of the physical trace evidence is most importantly used in the psychological researches. It is a very useful and valuable observational method of collecting data for psychological research studies yet data received through this technique are not always reliable and valid to be accepted. The physical traces, sometimes, cannot inform the investigator so accurately about the behavior of the respondents.

2. Archival Records: Archival records are preserves records about past events. They are the reports of the past activities. The records which are being updated are known as running records and the records of some specific events of history are known as episodic records. Archival records are useful to the investigator to supplement or compliment the information received from the physical trace evidences. Thus the investigator may keep him hidden or unnoticed in the process of data collection for his study. Archival records are always authentic yet sometimes they lack some information which is to be added or some unnecessary information which is to be
omitted. Some of the archival records are biased with easily overlooked information.

3. Document Review: Documents can be of different types and related to different topics. Review of documents is also one of the indirect observational methods. An investigator can review the documents which are existing and available. Documents can found in a printed or digital form. The documents can be performance reports, programme schedules, achievement ratings, financial budgets, institutional newsletters or minutes of the proceedings of the meetings. Before reviewing the document, the investigator should check the authenticity of the document. Review of document provides the investigator with basic information about the organization, its historical legacy, philosophy, goals, aims and objectives of the programme being operated in the organization of your study. The review of documents provides conceptual clarity and feasibility of the task under evaluation for his research study. When an investigator wants to develop some data collection tool, review of past documents is most useful for him. Before reviewing documents, the investigator should inquire about the existing and available documents, classify them according to his research needs and select them judging their authenticity. The selection of authentic and useful document for his study is the first step to follow for an investigator. Sometimes the information in the document may not be applicable, organized or up to date to be used. For safe and secured access of the documents, the investigator should pass through the legality and consent for reviewing the documents. The investigator may get all basic information, all fact and figures about the pace or event. Before reviewing the document, the investigator should ensure the authority with confidentiality. The investigator has to ensure that the data of the documents will be used for his research study and confidential data will remain confidential.

Thus review of documents is quite useful as an indirect observational method but it has certain limitations. The investigator should be very careful about accuracy, completeness and authenticity of the information provided by the document. The process of seeking legal and useful access of the document is very time consuming. Sometimes in the absence of authenticity, the information becomes invalid, and the investigator has to suffer a loss of time, money and energy. For getting valid and reliable information, the investigator should go into the authenticity of the sources of the document.
Thus various data collection methods are described and discussed in detail. The investigator should make an appropriate selection of the method suitable for his research study keeping in mind the objectives of the study, benefits and limitations of the adopted method and planning of expenses and duration for the study.

For the present study, the quantitative data collection method was used. The attitude scale constructed by the researcher was used to collect data required for the study. The proper protocol was followed in the process of data collection; initially an approval for collection of data was obtained from the Principals of higher secondary schools of science stream selected in the sample. Upon receiving the approval, the researcher personally visited the schools and met with the Principals and explained the purpose of the visit and handed over the Attitude Scale to the principals depending on the number of students in the higher secondary schools of science stream. The researcher requested the principals to distribute Attitude Scale to students to collect required data from the students.

The researcher informed the principals that the data would be used for the purpose of research only and they would not be misused in other way. The information provided by the students would be kept confidential and privacy norms would be followed strictly.

The researcher personally collected the Attitude Scale duly responded by the students of higher secondary schools of science stream. The scales have been scored by the system determined and the total raw scores were noted down on the score sheet. The total scores have been used for the establishment of various norms.

At the time of administering, the attitude scale was applied. The investigator had visited all clusters of Gujarat state. The scales have been scored by the system determined and the total raw scores were noted down on the score sheet. The total scores have been used for the establishment of various norms.

3.6 DATA ANALYSIS

Data analysis is an important stage of the process of research. After data collection is completed successfully, data analysis process starts. The process of analyzing the data involves three main activities- organizing the data, describing the data and interpreting the data. If someone wants choose clothes to wear, before making his right choice, he collects some information about what the weather forecast is, which
clothes are cleaned and which are dirty, what is the occasion you are going to attend, and above all your colour choice, feeling of being comfortable in certain clothes and many such questions’ answer will provide you data to help you in making right choice. Similarly in research studies, an investigator tries to seek answers of his research questions by gathering information related to the problem. He evaluates the collected information to reach at the final judgment. Analysis of data is a process of organizing and inspecting information. In quantitative research, it is a process of quantifying the information to derive the conclusions applying statistical techniques. The process of data analysis also involves cleaning, transforming and modeling data with a view to testing hypotheses to find the results. By interpreting the data, the investigator can make decision about the solution of the problem.

There are various ways and means of data analysis. Many statistical techniques have been sought for data analysis and data interpretation. Computer assisted techniques are also widely used in analyzing the collected data. Different techniques are used in the research studies of different disciplines. By analyzing and interpreting the data, an investigator tries to develop evidence to answer a research question of his study.

There are various techniques of data analysis. The data mining technique of data analysis is based on modeling. The finding of truth here aims at predicting the future consequences. Various statistical techniques are there to be applied for data analysis. According to the purpose of the research study, data analysis techniques of statistics are to be applied. And as such two types of data analysis can be used to arrive at the results. These two types of data analysis are exploratory data analysis and confirmatory data analysis. Exploratory data analysis deals with the sample data only and explores the results gained from the data analysis of the sample scores, and also the results are applied to the sample only, they cannot be generalized for the whole population. While confirmatory data analysis is used to accept or reject the hypotheses of the study. An investigator can use statistical or structural models for predictive analytics. He can use text analytics for qualitative research studies. The text analytics apply statistical, linguistic and structural techniques to analyze the textual information. The process of data analysis also involve in synthesizing or integrating data. Visualization of data and dissemination of data are also included in the process of data analysis. That is why the term data analysis is substituted by the term data modeling.
Figure-3.19 shows the classification of data analysis procedures.
Data analysis classified on the bases of the involvement of the variables in the process is known as univariate analysis and bivariate analysis. When a single variable is involved in the process of data analysis, that process is called univariate analysis and when more than one variable are involved in the process of data analysis, that process is called bivariate analysis. Univariate analysis uses the statistical techniques like mean, median, mode, standard deviation, and the distribution curves and describes the observations in tabular and graphical format. Bivariate analysis uses descriptive statistics to describe the relationship between the two variables and for this purpose it uses the measures of dependence like...
correlation and covariance. The observations of the data analysis are described in
the form of cross tabulations and contingency tables. For graphical presentation,
scatterplots are used.

There are, in fact, a number of software packages available that facilitate data
analysis. These include statistical packages like SPSS, SAS, and Microsoft Excel etc.
Similarly tools like spreadsheets and word processing software are multipurpose and
very useful for data analysis.

Present study had adopted descriptive statistics for data analysis and
interpretation. Descriptive statistics employ the quantitative description of the
qualities of collected data. In research methodology, there are two types of statistics
applied to the data analysis processes. They are known as descriptive statistics and
inferential statistics. If the investigator wants to explore the results of selected
sample of the study and confine their applications to the sample itself only, he uses
descriptive statistical techniques for analyzing his data. The inferential statistics is
also known as inductive statistics. If the investigator wants to generalize his results
applying them to the entire population of the research study, he uses inferential
statistics. The techniques of descriptive statistics are not based on the theory of
probability while the techniques of inferential statistics are based on the theory of
probability. However, the descriptive statistics are presented while using inferential
statistics for drawing the conclusions by analyzing data.

The statistical techniques such as measures of central tendency like mean,
median and mode, the measures of dispersion like standard deviation, kurtosis and
skewness are common in descriptive statistics. Descriptive statistics describes the
observations made about the sample. Descriptive statistics provides quantitative
summaries in the form of text or graph. The initial results of the descriptive statistics
may pave the way towards more extensive statistical analysis. In a recent time
descriptive data analysis techniques are known as exploratory data analysis
techniques.

The following statistics was used in data analysis:

1. Descriptive statistics was used in presenting information received from the
study in order to describe the characteristics of information of samples by
using frequency, percentage, mean and standard deviation.
2. Analysis statistics by using t-test was used to compare the level of job satisfaction of teacher educators with regard to demographic variables like gender, area age, experience, educational qualification, type of institution.

3. The significant differences were tested by post hoc test with LSD (Least Significant Deviation).

Thus, in this chapter the planning and procedure of the study is described in detail. The research methodology, sampling technique, the measuring instrument, and data collection and data analysis techniques are discussed. The next chapter deals with data analysis using statistical techniques.