

# METHODOLOGY

## CHAPTER—III

### METHODOLOGY

- 3.1 Introduction
- 3.2 Rationale of the study
- 3.3 Statement of the problem
- 3.4 Objectives of the study
- 3.5 Operationalization of the terms used
- 3.6 Hypothesis
- 3.7 Delimitation of the study
- 3.8 Data required for the study
- 3.9 Sources of data
- 3.10 Sample
- 3.11 Tools
  - 3.11.1 Tool to measure scientific attitude.
    - 3.11.1.1 Concept of Attitude
    - 3.11.1.2 Measurement of Attitude
    - 3.11.1.3 Attitude Scale
    - 3.11.1.4 Construction of Scientific Attitude Scale
    - 3.11.1.5 Identification of components of scientific attitude.
    - 3.11.1.6 Operationalization of Scientific Attitude
    - 3.11.1.7 Format and Nature of Statements.
    - 3.11.1.8 Development and Selection of Statement.

3.11.1.9 Response Mode

3.11.1.10 Tryout of Scientific Attitude Scale.

3.11.1.11 Scoring Procedure

3.11.1.12 Selection of Statements

3.11.1.13 The Final Format

3.11.1.14 Psychometric Properties of the Developed Scale.

Validity

Reliability

3.11.1.15 Fixing the Norms

3.11.1.16 Using the Norms

3.11.2 Tool to Measure Socio-Economic Status

3.12 Collection of Data

3.13 Analysis of Data

## CHAPTER— I I I

### METHODOLOGY

#### 3.1 INTRODUCTION

Methodology decides the fate of the study and its outcome. As such it is regarded as the heart of any research. Designing provides a picture for the whole study. It is therefore desirable to have a methodologically designed research plan. In this chapter the following aspects of the methodology of the present study have been discussed : objectives of the study, operationalisation of the terms used, hypotheses, delimitation of study, the data, sources of data, sampling, tools, procedure of data collection and analysis of data.

#### 3.2 RATIONALE OF THE STUDY

Science education, if properly conceived, should primarily be concerned with the education of mind rather than acquisition of isolated pieces of scientific knowledge. Scientific attitude, a very important attribute should be developed in the children who are the future citizens of any nation, if the objectives of science teaching are to be achieved. As the development

of scientific attitude has been recommended by almost all the commissions and committees appointed by Government of India, it would be essential to know to what extent we have been able to achieve this very objective of science teaching. It is more important due to its very nature of transferable to other situations in life which will help the future citizens of our country to solve the problems since we have people with different religion, caste, language, customs, traditions, it is expected that every citizen should have respect and tolerance for others customs, traditions, religion, etc. In such a situation, a person with scientific attitude will be in a better position to adjust in a complex society like ours and thus will be able to help others in maintaining peace and harmony which ultimately would lead to self progress and the progress of a nation.

Even in the present age of science and technology, the society is not free from superstitions. Patel (1991) found that female pupils are more superstitious than male pupils ; pupils studying in the schools situated in urban area are less superstitious than pupils attending the schools situated in rural area. Even in the developed country like U.S., adults and teen-agers believe in a variety of pseudoscientific phenomena Nickell (1992). Most of the time, in such superstitions, people waste

their valuable time, money and energy. Many a times, such beliefs of people invite troubles for themselves. A developing country like ours can not afford it's people wasting their time, money and energy. Other important problems which need attention of people are pollution, population explosion and energy crisis. In our country, where the natural resources are scarce and are going to be exhausted if we continue to use them at the present rate. We need people who are aware of such problems.

Scientific attitude which is very crucial for the development of nation so it is necessary to know the extent of its existence in our children. Alongwith the existence, its development is also important. For the development of scientific attitude it would be essential to know the related variables.

Out of 4703 studies conducted upto 1988 in our country which are reported in four surveys of Educational Researches, there are only 101 studies (150 due to multiple classification) in the area of science education. Again in the sub-area of scientific attitude, scientific aptitude and interest, there are only fourteen studies.

Ganguli and Vashishtha (1991) note that "Researches in Science Education should be urgently addressed to the problem of developing a scientific attitude in the

educands. Intensive studies will have to be directed towards this fundamental aspect of science education. What does the scientific attitude consist of precisely ? How can it be assessed accurately ? Research in science education awaits answers to these questions".

From the above discussion, it is clear that before thinking about developing scientific attitude, one has to assess its existence. So for the assessment of scientific attitude, first step should be to identify the possible components of scientific attitude and then develop an instrument based on these identified components which is capable of measuring the identified behaviors of it. Again, at present a very few such instruments to measure scientific attitude are available. But the investigator has decided to develop an instrument to measure scientific attitude for the following reasons.

1. The available tools did not consider all the components of scientific attitude which are considered in the present study.
2. The available tools were developed before a decade which may not have relevance at present.
3. This tool is developed keeping in mind the students of Std.X as it is the terminating year of secondary school education and it is expected that most of the

objectives of education for secondary school might have been achieved by this time. Hence the students of Std.X are the most appropriate group.

In the present study, alongwith the development of a tool to measure scientific attitude, an attempt is made to find relationship of scientific attitude with the variables like gender, socio economic status, location of school, achievement in science, and general achievement of students as the existing knowledge about such relationship is inconclusive i.e. the debate is still open.

### 3.3 STATEMENT OF THE PROBLEM

A STUDY OF SCIENTIFIC ATTITUDE AND ITS CORRELATES AMONG SECONDARY SCHOOL STUDENTS OF BARODA

### 3.4 OBJECTIVES OF THE STUDY

The study has been carried out with the following objectives :

1. To construct and standardize an instrument to measure scientific attitude of secondary school students.
2. To measure the scientific attitude of secondary school students of Baroda.

3. To study the nature of distribution of scientific attitude scores of secondary school students of Baroda.
4. To study the relationship of scientific attitude score with socio-economic status, achievement in science, general achievement of students.
5. To compare the scientific attitude of students with,
  - a) High, average and low SES students.
  - b) High, average and low science achievers.
  - c) High average and low general achievers.
  - d) Boys and Girls
  - e) Rural and Urban Students.

### 3.5 OPERATIONALISATION OF TERMS USED

#### 1. Scientific attitude score :

The score obtained by students on an instrument constructed and standardized to measure the scientific attitude. In the present study scientific attitude score is the measure of scientific attitude of students.

#### 2. General Achievement of Students :

The average score obtained by students in all the

compulsory school subjects at the March, 1996 Gujarat Secondary Education Board Examination.

**3. Achievement of Students in Science :**

The score obtained by students in science subject at the March, 1996 Gujarat Secondary Education Board Examination.

**4. Socio Economic Status (SES) of Students :**

The score obtained by students on the socio-economic status scale constructed by Desai (1986-87) will reflect the SES of students.

**5. Secondary School Students :**

The students who were studying in Std. VIII, IX and X as per education system followed by Gujarat Secondary Education Board.

**6. Urban Students :**

The students who were studying in the schools located in Urban area were considered urban students. An urban area should satisfy the following conditions (1) It should have a municipal corporation, cantonment board or notified town area committee. (2) It should have a minimum population of five thousand. (3) Atleast 75% of its male

working population should be engaged in non agricultural pursuits. (4) It should have a population of at least 400 persons per square kilometer.

#### 7. Rural Students :

The students who were studying in the schools located in rural area were considered rural students. A rural area should have a population below five thousand, with 75% of the population engaged in agricultural pursuits.

#### 3.6 HYPOTHESES

- Ho1 : There will be no significant relationship between the scientific attitude and socio economic status (SES) of students.
- Ho2 : There will be no significant relationship between the scientific attitude and achievement of students in science.
- Ho3 : There will be no significant relationship between the scientific attitude and general achievement of students.
- Ho4 : There will be no significant difference in the mean scientific attitude of boys and girls.

- Ho5 : There will be no significant difference in the mean scientific attitude of urban and rural students.
- Ho6 : There will be no significant difference in the mean scientific attitude of high socio economic status (SES) students, average social economic status (SES) students and low social economic status (SES) students.
- Ho7 : There will be no significant difference in the mean scientific attitude of high achievers in science, average achievers in science and low achievers in science.
- Ho8 : There will be no significant difference in the mean scientific attitude of high general achievers, average general achievers and low general achievers.
- Ho9 : There will be no significant difference in the mean scientific attitude of urban and rural students with respect to their gender.
- Ho10 : There will be no significant difference in the mean scientific attitude of urban and rural students with respect to their SES.

Ho11 : There will be no significant difference in the mean scientific attitude of boys and girls with respect to their SES.

Ho12 : There will be no significant difference in the mean scientific attitude of urban and rural students with respect to their achievement in science.

Ho13 : There will be no significant difference in the mean scientific attitude of boys and girls with respect to their achievement in science.

Ho14 : There will be no significant difference in the mean scientific attitude of urban and rural students with respect to their general achievement.

Ho15 : There will be no significant difference in the mean scientific attitude of boys and girls with respect to their general achievement.

Ho16 : There will be no significant difference in the mean scientific attitude of urban and rural boys and girls with respect to their SES.

Ho17 : There will be no significant difference in the mean scientific attitude of urban and rural boys

and girls with respect to their achievement in science.

Ho18 : There will be no significant difference in the mean scientific attitude of urban and rural boys and girls with respect to their general achievement.

### 3.7 DELIMITATION OF THE STUDY

- (1) The study was delimited to the students who were studying in std. X (the terminating year of secondary school education in Gujarat) in the schools of Baroda District. It is expected that most of the objectives of secondary school education should have been achieved by the students. Scientific attitude (one of the objectives of teaching science at secondary school education) is one of the variables of the present study. Hence it was decided to measure the scientific attitude of students who were studying in std. X in the schools of Baroda District during the academic year 1995-96.
- (2) Secondly, to obtain the valid and reliable information on two of the variables viz. general achievement and achievement of students in science, std. X was preferred mainly due to the following reasons.

- the curriculum in the entire state of Gujarat is Uniform.
- at the end of each academic year, the Gujarat Secondary Education Board, Gandhinagar (Examination Wing, Vadodara) is conducting a common public examination.
- at the scoring of answers of all the students of Gujarat is uniform.

All these factors, facilitate the judicious comparison of general achievement and achievement in Science with other variables of the present study.

- (2) The tool to measure scientific attitude of students was constructed in GUJARATI language. As the sample consisted of students studying in schools located in urban as well as rural areas and there are a very few schools located in rural area providing instruction to students through English Language, the tool to measure scientific attitude of students was constructed in GUJARATI language.

### 3.8 DATA REQUIRED FOR THE STUDY

In order to achieve the stated objectives, the following data were required.

1. Scientific attitude score.
2. General achievement.
3. Achievement in Science.
4. Socio-economic status.
5. Gender.
6. Location of Schools.
7. Number of schools in each of the twelve talukas of Baroda District and Baroda city.
8. Population of the villages of selected schools.

### 3.9 SOURCES OF DATA

The data required for the present study as mentioned above were available from various sources mentioned below:

1. The students who were studying in std. X in the schools of Baroda District. From these students data pertaining to their scientific attitude, socio-economic status, gender and location of schools were available.
2. Official documents and records.
  - (a) The result of the public examination conducted by Gujarat Secondary Education Board, Gandhinagar, during the academic year 1995-96 provided data pertaining to General Achievement and Achievement of students in Science.

(b) The records of the office of the District Education Officer, Baroda provided data pertaining to the number of schools in each of the twelve talukas of Baroda District and Baroda city. It also provided data pertaining to population of the villages of selected schools.

### 3.10 SAMPLE

The sample for the entire study was formed by the students who were studying in std. X in the selected Gujarati medium schools of Baroda district located in urban as well as rural area. In the present study, as the tool to measure scientific attitude of students was to be constructed and standardized which was phase-I of the study, it demanded two sets of sample for the standardization of the tool. These two sets of sample are described alongwith the construction of tool to measure scientific attitude (3.11.1). The phase-II of the present study dealt with studying the relationship of scientific attitude with variables like General achievement, Achievement in Science, Socio-Economic Status, Gender and Location of school of students for which the sample was selected by using cluster sampling technique. A sample of 596 students studying in Std.X in thirteen different schools of Baroda District was randomly selected from the

population of students studying in 347 secondary schools in Baroda District during the academic year 1995-96.

Donald Ary, et. al. (1972) described that, "It is very difficult, if no impossible, to list all the members of a target population and select the sample from among them. The population of U.S. High School Students, for example, is so large that one can not list all of its members for the purpose of drawing a sample. In addition, it would be a very expensive undertaking to study a sample that is scattered all around the U.S. In this case it would be more convenient to study subjects in NATURALLY OCCURRING GROUPS or CLUSTERS. That is, the researcher would choose a number of schools randomly from a list of schools and then include all the subjects in those schools in his sample. This kind of sampling is referred to as CLUSTER SAMPLING , Since the unit chosen is not an individual but a group of individuals who are naturally together".

So keeping this in mind and by following two major considerations mentioned hereunder the sample was selected by cluster sampling technique.

1. The students who were studying in the schools which were selected for PILOT administration of the tool to measure scientific attitude were not selected.

2. As far as possible, one rural school from each of the twelve talukas were selected and one urban school from each of the major areas of Baroda city were selected.

Table 3.1 shows the number of schools in each of the twelve talukas of Baroda district and in Baroda city.(urban).

**TABLE 3.1**  
**Number of Secondary Schools in Baroda District.**

Sr.No.	Name of Taluka	No. of Schools
1.	Vadodara	28
2.	Padra	28
3.	Karjan	19
4.	Savali	26
5.	Vaghodia	11
6.	Dabhoi	24
7.	Shinor	09
8.	Tilakwada	08
9.	Nasawadi	08
10.	Pavijetpur	20
11.	Chhotaudepur	19
12.	Sankheda	19
13.	Vadodara (City)	128

\* SOURCE : Office of the District Education Officer,  
Baroda, 1996.

As the number of students studying in std. X was different in different schools, especially in the schools located in urban and rural area, to keep approximately same number of students from urban and rural schools six schools from urban and seven schools from rural area were selected randomly. The selected schools with the number of students who formed the sample of the present study are shown in the following tables.

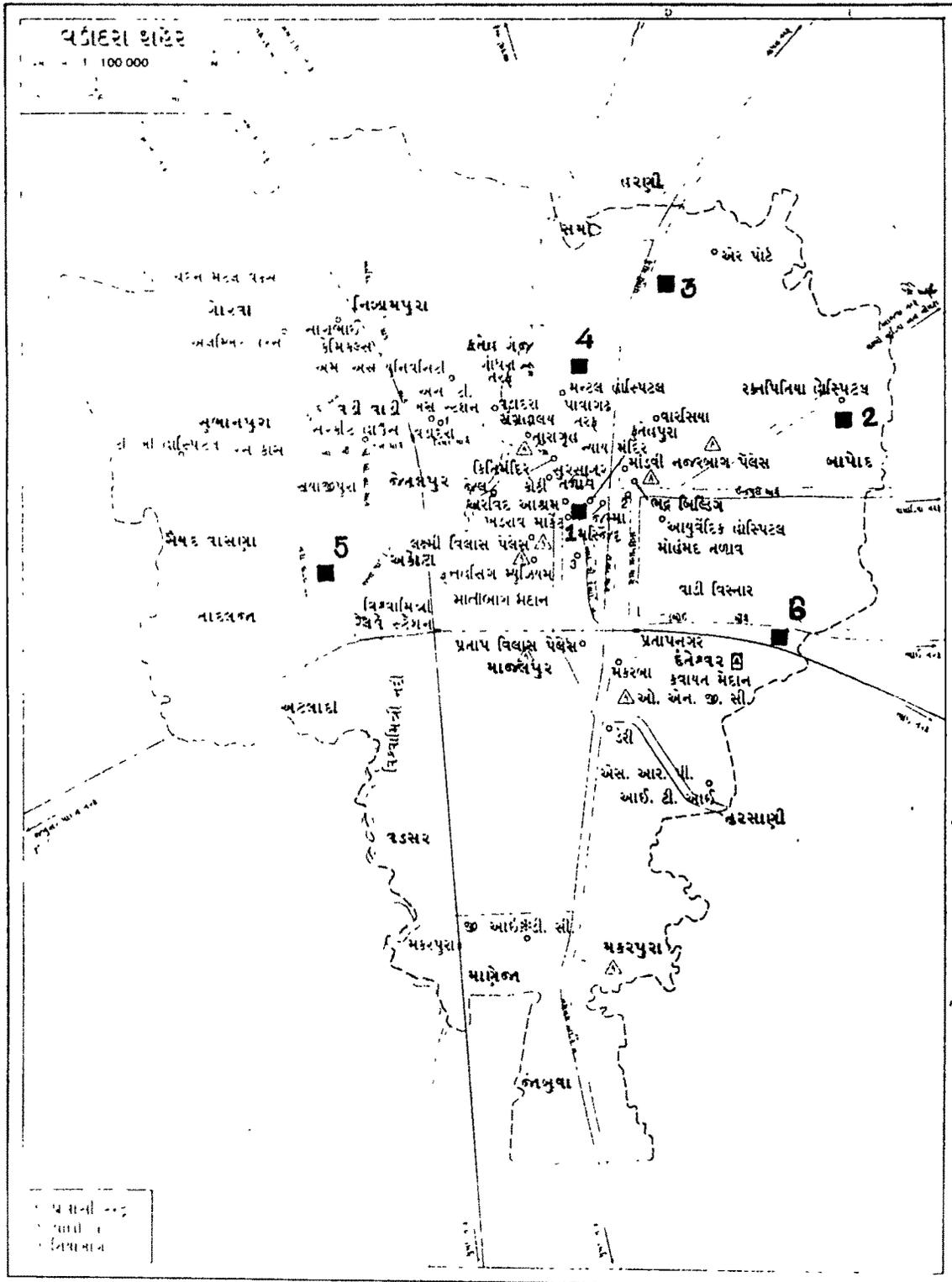
**Table. 3.2**

**Distribution of Sample of Students over Gender and Location of Schools.**

	RURAL	URBAN	TOTAL
BOYS	187	147	334
GIRLS	105	157	262
TOTAL	292	304	596

Figure 3.1 and figure 3.2 show the location of schools in Baroda district and Baroda city respectively.

Figure 3.2  
Map Indicating the Location of Schools in Baroda City.  
\*      ■ : Location of School



### 3.11 TOOLS

A research tool plays a major role in any worthwhile research, as it is the sole factor in determining the sound data and in arriving at perfect conclusions about the study in hand, which, ultimately, helps in providing suitable remedial measures to the problem concerned.

In the present study, to collect the required data the following two tools were used.

1. Tool to measure scientific attitude.
2. Tool to measure socio-economic status.

#### 3.11. 1 Tool To Measure Scientific Attitude

The tool to measure scientific attitude of students was constructed and standardized by the investigator. The tool which was used to measure scientific attitude was SCIENTIFIC ATTITUDE SCALE (SAS) constructed by following "The method of Summated Rating" given by Likert (1932), with minor variations. The detailed process of construction and standardization of SAS is as follows:

##### 3.11.1.1 Concept of Attitude

Attitude refers to feeling of an individual. Thurstone (1946) defined an attitude as the degree of positive or negative affect associated with some psychological

object. By psychological object, Thurstone means any symbol, phrase, slogan, person, institution, ideal, or idea toward which people can differ with respect to positive or negative affect. A particular job, for example, may be a psychological object. A political party, the title of a book, a minority group, a nation, labour unions, a religion, a teacher, a subject, a laboratory and a particular food are still examples of psychological objects.

In the literature of psychology, the terms "affect" and "feeling" are used interchangeably. An individual who has associated positive affect or feeling with some psychological object is said to like that object or to have a favourable attitude toward the object. An individual who has associated negative affect with the same psychological object would be said to dislike that object or to have an unfavourable attitude toward the object.

#### **3.11.1.2 Measurement of Attitude**

Attitude of individuals can be measured by manifest expression of them, in response to direct questioning or can be judged by direct observation of behaviour. They can also be judged by procedure like projective techniques. But all these methods suffer from one or the other disadvantages. The reluctance of many individuals

to give public expression to their feeling is an obvious disadvantage of the method of direct questioning. It is also true that sometimes our feelings about a psychological object are so mixed and confused that it is difficult for us to evaluate how we feel by introspective methods. We may, for example, have both positive and negative affect associated with the same psychological object. How, then, are we to weigh and evaluate the strength or intensity of the two opposed affects and to decide whether we like or dislike the object? Such evaluations may demand more objectivity and insight than some individuals are capable of giving, and certainly upon the spur of the moment and in response to a direct question.

Similarly, the method of direct observation of behaviour can not profitably be applied, if one has to determine attitudes of a large number of people toward some object as the researcher may not have the opportunity to observe in detail the behaviour of all the individuals in whom he is interested. He might have to spend considerable time waiting for the desired behavioural interactions between the individuals under observation and the psychological objects. If the behaviour with respect to the object does eventually occur, it, of course, may also fail to reveal the

feelings of the individual. In many cases behaviour is designed to conceal feelings.

The above mentioned possibilities illustrate that there is no necessary one-to-one correspondence between overt behaviour and attitudes. Attitudes as factors influencing or determining behaviour, may be one of many such, and not necessarily the most preponent. If we expect to predict behaviour from feelings or attitudes, then these other factors must be taken into account. And similarly, if we expect to infer attitudes or feelings from direct observations of behaviour, we must always consider the possibility that our inference will be incorrect simply because the behaviour may be determined by factors other than the individual's feelings.

Another disadvantage, that goes with both these methods viz. direct questioning and direct observation, is that discrimination of the levels of attitude is very poor. The individuals can at best be classified into two to three categories. Moreover, the reliability of these methods is also very poor.

Projective techniques again suffer from the disadvantage of their being very cumbersome and time consuming. Quantification of collected informations is also difficult.

The most convenient and widely used technique of measuring attitude is the use of a "SCALE" An attitude scale measures both, the direction of affect, and its magnitude. It can also be administered to large groups of individuals at a time.

#### 3.11.1.3 Attitude Scale

An attitude scale consists of a number of items that have been carefully prepared, selected and edited according to certain criteria. Items of attitude scale are called statements, which can be defined as 'anything that is said about a psychological object'. An individual responds to these statements by indicating his/her agreement or disagreement with which he/she agrees.

There are basically two major types of scaling techniques and they go with the names of their authors. They are :

Thurstone's method of scale construction

Likert's methods of scale construction

Other technique are same only with minor variations or with combination of these two methods.

Although attitude scales are widely used in the field of researches related to education and psychology for the measurement of attitude, they are also not full proof.

Sukhia, et. al. (1970), describe some limitations of attitude scale as;

Attitude scale are not exact in so much as,

- there is no basis for believing that the five positions indicated in the (Likert for example) scale are equally spaced,
- it is unlikely that the statements are of equal value in 'forness' or 'againstness',
- it is doubtful whether equal scores obtained by several individuals would indicate equal favourableness towards a given position. Different combinations of positions can yield equal score values without necessarily indicating equivalent positions of attitude or opinion,
- it is unlikely that a respondent can validly react to a short statement on a printed form in the absence of real life-qualifying situations,
- inspite of anonymity of response, individuals tend to respond according to what they should feel rather than what they really feel.

However, until more precise measures are developed, the attitude scale or opinionnaires remain the best devices for the purpose of measuring attitudes and

beliefs in social research. They determine the direction and intensity of a person's feelings for or against some belief or practice. They are used to measure any changes in attitude which may result from factors introduced purposely or occurring independently. They are also used to survey the attitude of a large number of individuals.

Out of the two major methods as mentioned above, for attitude scale construction, the investigator in the present study had selected Likert method to construct scientific attitude scale (SAS) due to under-mentioned reasons :

- it has been claimed by Likert (1932) that the method of summated ratings in his survey of the attitudes of employed and unemployed men was adopted because of its relative simplicity. Rundquist and Sletto (1932), used this method in developing the attitude scale contained in the Minnesota survey of opinions and they also expressed their belief that the method was less laborious than that developed by Thurstone,
- secondary, it is less time consuming, Edward and Kenney (1946), in their comparative study of the method of equal appearing intervals and the method of summated ratings, estimated the time required to construct equal appearing interval scale, was

approximately twice that required by the method of summated ratings,

- scale constructed by the Likert method yield higher reliability coefficient with fewer items than scales constructed by the Thurstone method. This was the finding arrived at by Hall (1934), Seiler and Hough (1970),
- to arrive at a summated score of the individual since the attribute 'scientific attitude' was accepted as being composed of various components.

However, deviation from the model was made. Unlike the Likert's model which requires that all the statements pertain only to a single reference point which is the psychological object, the scale under consideration described the reference point as being constituted of certain components . Possessing only any one of the components to a very great extent would not lead to placing the individual in the right extremity of a hypothetical continuum of scientific attitude. Since it is logically held to be a totality of different components which work in a contributory manner, an individual in order to be highly scientific needs to have in his pattern of behaviour, all the components to a certain degree. The component wise break-up was a matter of convenience evolved to ensure representation of the

totality of behaviours comprising scientific attitude, which when it operates in an individual is to be viewed as a single entity.

#### **3.11.1.4 Construction of Scientific Attitude Scale**

In the present study, the investigator constructed a scientific attitude scale by "The Method of Summated Ratings " given by Likert (1932). The description of the detailed process of construction and standardization is presented below :

#### **3.11.1.5 Identification of Components of Scientific Attitude**

Attempts to construct instruments to measure scientific attitude have chiefly been made by researchers abroad. Such efforts have resulted in a few valid and reliable instruments for example, Attitude Measuring Instrument in Science Education, Lowrey (1966), Inventory of Scientific Attitude, Moore (1970), Scientific Attitude Scale (SAS), Billet and Zakharidas (1975), Test of Scientific Attitude (TSA), Kozlow and Marshall (1976), Test of Scientific and Related Attitudes (TOSRA), Fraser (1978). Most authors in the literature referred find scientific attitude to be an attribute made of certain behaviours.

In the Indian context too, a very few instruments to measure scientific attitude exist although Indian workers namely, Rai (1963), Jain (1967), Kohli (1969), Branganza (1970), Singh (1971), Kulkarni (1975), Gopal Krishnan (1975), Sharma (1978), Srivastava (1980), Sindhe (1982), Ravindranathan (1983), Vardhini (1983), Ghosh (1986), and Rao (1989), and others in the field do recognised this attribute to be a significant result of science teaching. Referring to their work and other available literature with regard to scientific attitude, it was observed that there is a great deal of concurrence among the researchers in the field on the question of identifying which behaviours may be described as those of scientific attitude. This is obvious from the operationalisation of scientific attitude by the following researchers in their study.

Jain (1967), operationalised scientific attitude as

(A) Intellectual Domain :

- Belief in cause and effect relationship.
- Looking for sufficiency of data in coming to certain conclusions.
- Arousing intellectual curiosity.

(B) Affective Domain :

- Respecting others production of data with a view to verify it.
- Preparedness to share his findings with others.
- Believing that scientific inventions are not bad in themselves.

(C) Cognitive Domain :

- Showing intellectual honesty.
- Doing a task to its logical conclusion.
- Withholding judgement.

(D) Metaphysical and Mythological Domain :

- Freedom from superstitions.
- Freedom from Prejudices.
- Disbelieving fatalism or avoiding bigotry and fanaticism.

Branganza (1970), operationalised Scientific attitude as,

- intellectual honesty,
- high order of curiosity,
- freedom from superstitions,
- confidence intelligence of belief that one can solve problems,
- belief in progress,
- belief in cause and effect relationship,

- respect for evidence,
- suspended judgement,
- freedom from prejudices, and
- modesty or humility.

Srivastava (1980), operationalised it as,

- rationality,
- curiosity,
- openmindedness,
- aversion to superstition,
- objectivity,
- intellectual honesty, and
- suspended judgement.

Vardhini (1983), operationalised scientific attitude as,

- empiricism ,
- curiosity ,
- freedom from bias ,
- openmindedness ,
- curiosity ,
- intellectual honesty ,
- seeks evidence , and
- observation.

NPE (1986), noted as, "Science Education will be strengthened so as to develop in the child well defined

abilities and values such as the spirit of inquiry, creativity, objectivity, the courage to question, and an aesthetic sensibility".

A close look at the identification of the components and/or behaviours of scientific attitude reveals that there is no total agreement by researchers on a single definition of scientific attitude. The researchers have tried to ensure comprehensibility while operationalisation of scientific attitude. However, it was observed that the important components like Environmental awareness and Courage to question of scientific attitude did not find place in their studies.

After thoroughly exploring the literature available on scientific attitude, the following components of it were arrived at :

1. Rationality ,
2. Curiosity ,
3. Objectivity ,
4. Open-mindedness ,
5. Criticalmindedness ,
6. Intellectual Honesty ,
7. Observation ,
8. Humility ,
9. Environmental Awareness ,
- 10.Courage to question.

The identification was followed by a related exercise of listing behaviours which may be used to describe a particular component. The behaviours in respect of each component have been presented in what follows :

#### 1. RATIONALITY

- \* The search for plausible solutions is not affected by superstitions explanations.
- \* Is cautious not to permit decisions to be affected by personal likes or dislikes, fear, anger or ignorance.
- \* Belief in cause effect relationship
- \* Aversion to superstitions.

#### 2. CURIOSITY

- \* Tendency to know more about events, objects and phenomena which can not be explained by the existing knowledge.
- \* Reading to get informations.
- \* Initiating and carrying out investigations
- \* Inclination to observe.

### 3. OBJECTIVITY

- \* Is not guided by personal feelings.
- \* Does not let his feelings interfere with the impersonal judgement needed in collecting and interpreting data.

### 4. OPENMINDEDNESS

- \* Respect for others point of view
- \* Willingness to change opinion on getting evidence to the contrary.
- \* Considering several possible opinions while investigating problems.

### 5. CRITICALMINDEDNESS

- \* Insists upon evidence to support another person's statement.
- \* Questions to source of information and its reliability.
- \* Often asks questions like :
  - What evidence do you have to support your view ?
  - How do you know ?
  - Why do you believe that ?

## 6. INTELLECTUAL HONESTY

- \* Reporting observations even when they contradict one's hypothesis.
- \* Acknowledging work done by others.
- \* Expresses a reluctance to compromise with truth.

## 7. OBSERVATION

- \* Precision in observation
- \* Detailed observation.

## 8. HUMILITY

- \* Develops a recognition of his own limitations as well as the limitations inherent in science.

## 9. ENVIRONMENTAL AWARENESS

- \* Judicious use of energy.
- \* Acknowledging the fact that threat to environmental equilibrium is more of a threat to human life.

## 10. COURAGE TO QUESTION

- \* Asks questions without having a fear of what others will think if he does so.

From a study of the behaviours listed under different components, one may perceive that there is overlapping in

respect of some behaviours. This may be observed due to the fact that the attribute scientific attitude is the resultant of several behaviours and therefore, it may not be possible to categories with strict certainty behaviours under various components so as to make them totally exclusive of each other.

Thus identified components of scientific attitude with the list of behaviours under each of them were referred to twenty four experts in the field. This exercise was carried out to collect the opinion of experts on the identified components and the behaviours under each component with regard to their :

- appropriateness ,
- relevance ,
- capacity

to describe the construct scientific attitude. A copy of the letter which was sent to experts and the list of experts are given in Appendix I and II respectively..

Most of the experts who responded to the letter agree that the identified components and behaviours were appropriate, relevant and had capacity to describe scientific attitude comprehensively. However, many of them suggested to merge a few of the components which have similarity to a certain extent. According to them

reduction of ten components to six or seven components would not only lead to in-depth concentration on the study of scientific attitude but also would facilitate the further statistical treatment on the SAS.

Considering the above mentioned valuable suggestions of the experts, four of the identified components of scientific attitude namely, Criticalmindedness, Courage to question, Objectivity and Humility were merged into the other components having nearly similar meaning.

Accordingly, "Criticalmindedness" and "Courage to question" were clubbed with "Curiosity" and "Humility" was clubbed with "Environmental Awareness". Also, the behaviours like " Ability to confess ignorance and Having reasons for questions were added to the component "Intellectual Honesty" to make its meaning comprehensive.

#### **3.11.1.6 Operationalisation of Scientific Attitude**

Based on the above discussed procedure of the identification of the components of scientific attitude and the list of behaviours under each of the identified components of scientific attitude, for the present study. "SCIENTIFIC ATTITUDE" was operationalised as the construct which comprises of the following components:

1. Rationality
2. Curiosity

3. Open-mindedness
4. Intellectual Honesty
5. Observation
6. Environmental Awareness.

#### 3.11.1.7 Format and Nature of Statements :

To study the magnitude of scientific attitude in individuals it would be legitimate to observe the occurrence of the behaviours comprising the attribute in students in daily life situations. The practicalities of the situation under which the present attempt was made imposed certain limitations in the adoption of the observational technique in a full-fledged manner apart from the basic limitations of the technique of observation for attitude measurement which are discussed in measurement of attitude. These limitations were in terms of the number of students to be observed, the scatteredness of students in terms of geographical dimension. Nevertheless, due to the importance of studying individuals in daily life situations it was decided to present these situations in the form of items constituting a measuring instrument to which students would respond in a written manner. The choice of such a procedure was considered logically justifiable on the grounds that although these developed items would not represent the daily life situations par se, it was

thought that these items had capacity to act as stimuli in the situations described by them since these were probable in the environs of any students and therefore, could act as sufficiently contrived forms of the actual daily situations.

Each test item presented a statement which described a situation in which the individual could hypothetically be placed and could be reacting in a particular manner in the hypothetical situation. These items were provided with five options namely, strongly agree, agree, undecided, disagree and strongly disagree. There were positive polarity items to measure foreness and negative polarity items to measure againstness of scientific attitude.

#### **3.11.1.8 Development and Selection of Statements**

With the behaviours described under each component as the reference, and the nature of statements to be developed clarified the statements were worded. While wording the attitude statements the suggestions of Wang (1932), Thurstone and Chave (1929), Likert (1932), Bird (1940), and Edwards and Kilpatrick (1948), as summarized by Edwards (1969), regarding the construction of attitude scales were followed. The summary of their suggestions are presented below .

1. Avoid statements that refer to the past rather than to the present.
2. Avoid statements that are factual or capable of being interpreted as factual.
3. Avoid statements that may be interpreted in more than one way.
4. Avoid statements that are irrelevant to the psychological object under consideration.
5. Avoid statements that are likely to be endorsed by almost everyone or by almost no one.
6. Select statements that are believed to cover the entire range of the affective scale of interest.
7. keep the language of the statements simple, clear, and direct.
8. Statements should be short, rarely exceeding twenty words.
9. Each statement should contain only one complete thought.
10. Statement containing universals such as all, always, none, and never often introduce ambiguity and should be avoided.

11. Words such as only, just, merely, and others of a similar nature should be used with care and moderation in writing statements.
12. Whenever possible, statements should be in the form of simple sentences rather than in the form of compound or complex sentences.
13. Avoid the use of words that may not be understood by those who are to be given the completed scale.
14. Avoid the use of double negatives.

An initial pool of 106 statements was prepared by the investigator by taking the help of experts in the field. These statements were scrutinised by a panel of two experts and the investigator to judge their representation of daily life situations to be within the familiarity of students of the target group. The statements were also examined in terms of their representing the behaviours denoted under each component. Also, statements were studied to see that while describing the situations they do not suggest the respondent to opt for a particular option, and that these statements were content free. Through the above procedure, a total of ninety statements distributed across the components was selected for the tryout form. The distribution of statements with respect to the

components and the polarity (positive or negative) was as follows.

**Table 3.5**

**Distribution of statements on the tryout form of the scientific attitude scale.**

Components	Number of Statements with		Total number of statements
	Positive Polarity	Negative Polarity	
Rationality	10	10	20
Curiosity	11	09	20
Openmindedness	08	10	18
Intellectual Honesty	06	06	12
Observation	04	03	07
Environmental Awareness	07	06	13
Total	46	44	90

Further to judge the aspect of correctness and suitability of language, these ninety statements were referred to the language experts. To ensure the comprehension of students in terms of language and vocabulary used in the statements, these statements were

given to ten students of Stx.X who were purposefully selected from two schools of Baroda city namely, Jeevan Sadhana School, Navi Dharti, and New Era High School, Makarpura, Baroda.

The statements were assigned number from one to ninety. The statements were randomly arranged to constitute the scale by following randomization with respect to statement number. Randomization for the arrangement of statement was carried out to eliminate patterned responses which might result if all the statements belonging to a particular component were concentrated at one point of the format. The arrangement of statements in the format was as follows :

Table 3.6

Distribution of the Statements according to the component and polarity.

Statement no.	Polarity	Component
1	P	C
2	P	R
3	N	R
4	P	I
5	N	R
6	P	OB

Table 3.6: Cont...

Statement no.	Polarity	Component
8	P	O
9	P	C
10	P	C
11	P	I
12	N	C
13	P	I
14	N	I
15	P	R
16	P	C
17	N	I
18	P	C
19	P	O
20	P	O
21	P	R
22	P	E
23	N	I
24	N	I
25	P	C
26	P	E
27	P	C
28	P	C
29	N	OB
30	N	E

Table 3.6: Cont...

Statement no.	Polarity	Component
32	N	I
33	N	O
34	N	C
35	N	E
36	P	E
37	N	C
38	P	I
39	P	R
40	N	O
41	P	R
42	P	O
43	N	O
44	N	C
45	N	R
46	P	OB
47	N	O
48	N	O
49	N	E
50	P	C
51	N	R
52	N	OB
53	P	C
54	P	R

Table 3.6: Cont...

Statement no.	Polarity	Component
55	N	I
56	N	O
57	P	E
58	P	OB
59	P	R
60	P	R
61	N	C
62	N	O
63	N	C
64	N	E
65	P	O
66	N	O
67	P	O
68	P	I
69	P	OB
70	N	O
71	N	E
72	N	R
73	N	C
74	P	O
75	P	I
76	P	C
77	P	E

Table 3.6: Cont...

Statement no.	Polarity	Component
78	N	E
79	N	C
80	P	R
81	N	C
82	P	O
83	N	R
84	N	OB
85	N	R
86	N	R
87	N	R
88	P	E
89	N	O
90	P	E

**C: Curiosity**

**R: Rationality**

**I: Intellectual Honesty**

**O: Openmindedness**

**OB: Observation**

**E: Environmental Awareness**

**N: Negative Polarity**

**P: Positive Polarity**

The format which thus resulted was made complete by providing a section proceeding the statements, wherein,

relevant information regarding the respondent was sought, necessary directions to respond the scale, and an illustration of performance on statements were provided. This format of the scientific attitude scale was used for the tryout study and is given in Appendix-III.

#### **3.11.1.9 Response Mode**

While an individual responds to the scale, he would read each statement, which as mentioned earlier, described the hypothetical situation. It was expected that he would place himself in the situation represented in the statement. He would decide one of the five options namely, strongly agree, agree, undecided, disagree and strongly disagree and indicate it by putting a tick mark " ✓ " in the corresponding box. The mental processes demanded by situational type of statements as the one included in the SAS involved understanding of the situation presented, discriminating the options, simultaneously placing oneself in the situation and deciding the degree of agreement or disagreement with the situation.

#### **3.11.1.10 Tryout of Scientific Attitude Scale**

To make a selection from the pool of ninety statements a tryout study was conducted on a sample of 379 students during the month of October, 1995. The schools which were

selected for the final sample were not included for this purpose. This is because the correlation and interaction effect of scientific attitude with other variables of the present study was to be studied. So the attribute scientific attitude of students was to be measured using the same scale. If the tryout were to be carried out on the students who would constitute the sample for the second phase of study, the familiarity with statements would reduce the genuineness of the data and jeopardize the results. Since there was only a need to get students of Std.X in Gujarati Medium, Seven Schools - two Urban and five rural were selected. Details regarding the sample used for the selection of statements are presented in the table which follows. Figure 3.3 and figure 3.4 show the location of schools from urban and rural area of Baroda selected for pilot study.

Table 3.7

Description of sample of students considered in selection of statements on scientific attitude scale.

Sr. no.	Name of the School	Location	Number of	Total	
1	Vidya Vikas Vidyalaya, Ellora Park, Baroda	Urban	91	196	
2	Sardar Vinay Mandir Karelibaug, Baroda	Urban	105		
3	Sevasi High School, Sevasi, Ta & Dist- Baroda	Rural	60	183	
4	Dabhosa English School, Dabhasa, Ta. Padra, Dist Baroda	Rural	35		
5	Mahatma Gandhi Sarvajanic Vidyalaya, Kundhela, Ta. Dabhoi Dist- Baroda	Rural	29		
6	Sanskar Vidyalaya Pipalav, Ta.- Waghodia	Rural	28		
7	M.P. Patel High School, Dasarath,	Rural	31		
	Total				379

Figure 3.3  
Map Indicating the Location of Urban Schools for Pilot Study.  
\* : Location of School

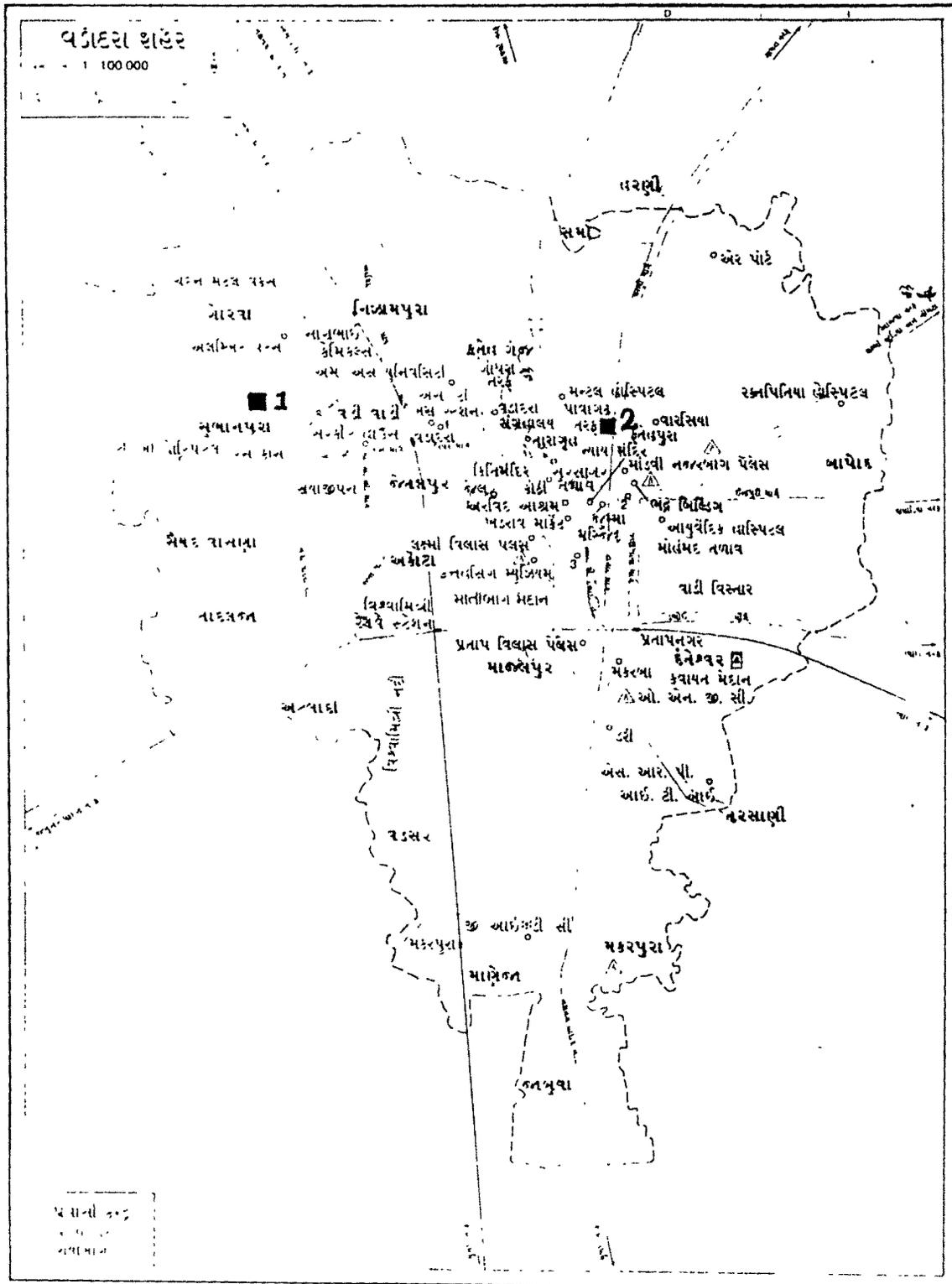
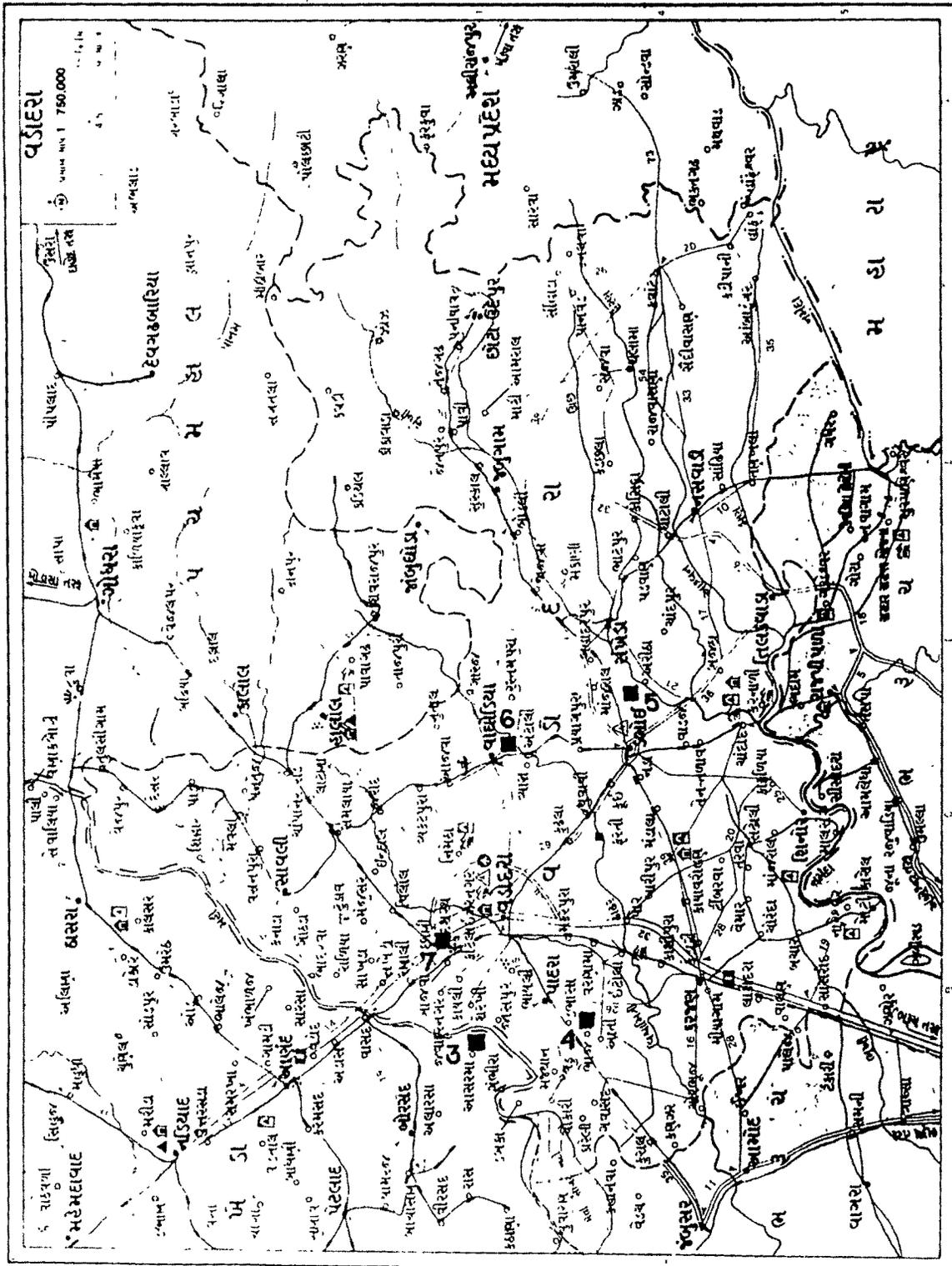


Figure 3.4  
Map Indicating the Location of Rural Schools for Pilot Study.  
\* : Location of School



To ensure that the tendency to seek conformity in responding was removed, students were clarified regarding the purpose of the test namely, to know their specific behaviour in the situations presented rather than evaluating their behaviour as right or wrong. Students were placed at ease in the testing situation. On an average, the time taken by students in each school was about an hour and half.

#### 3.11.1.11 Scoring Procedure

As has been mentioned earlier, the options represented degrees of scientificity, from high to low.

The five options were :

SA - Strongly agree

A - Agree

UD - Undecided

D - Disagree

SD - Strongly disagree

After the administration of the scale, it was scored by keeping into consideration the scoring procedure suggested by Likert.

For SA response, 5 Score

For A response, 4 score

For UD response, 3 score

For D response, 2 score

For SD response, 1 score

For statements of negative polarity, the scoring system was reversed i.e.

For SA response, 1 Score

For A response, 2 score

For UD response, 3 score

For D response, 4 score

For SD response, 5 score

Accordingly, the maximum score attainable on the scale was 450 and the minimum score would be ninety. The values 1,2,3,4, and 5 are only ascriptions necessitated from a formal measurement point of view. As for as the conceptualization of the construct is concerned, they represent only high and low degrees of scientificity. In view of the premise that there would be a certain degree of scientificity in every respondent, and that scientific attitude is a composite of behaviours, the situation wherein any individual may secure a score of ninety on the total scale will not arise.

With the above guidelines followed for scoring, the responses were scored and the summated score in respect of each respondent was arrived at. The utilisation of data for statement selection is discussed in what follows:

### 3.11.1.12 Selection of Statements

For finally selecting the statements that would differentiate between the high group and low group under mentioned procedure suggested by Likert (1932), was adopted :

#### Step - I

The investigator considered the frequency distribution of scores based upon the response to all statements. Then 27% of the subjects (NH= 100) with highest total scores and also 27% of the subjects (NL=100) with the lowest total scores were selected for item analysis. They were termed as high and low groups.

#### Step- II

In evaluating the responses of the high group and the low group on each statement 't' values were computed by using undermentioned formula:

$$t = \frac{\bar{X}_H - \bar{X}_L}{\sqrt{\frac{S_H^2}{N_H} + \frac{S_L^2}{N_L}}}$$

Where,

$\bar{X}_H$  = the mean score on a given statement for the high group

$\bar{X}_L$  = the mean score on the same statement for the low group.

$S_H^2$  = the variance of the distribution of responses of the high group to the statement.

$S_L^2$  = the variance of the distribution of responses of the low group to the statement.

$N_H$  = the number of subjects in the high group.

$N_L$  = the number of subjects in the low group.

The 't' value for ninety statements as calculated by using the above formula is given in the table 3.8.

Table : 3.8

The Mean, Sd and 't' values of ninety statements.

Stat. no.	Mean		SD		t-value
	UPPER	LOWER	UPPER	LOWER	
1	3.6	3.36	1.333	1.467	1.42
2	3.23	2.9	1.543	1.439	1.63
3	4.14	3.14	1.247	1.443	5.27
4	3.61	3.55	1.385	1.366	0.3
5	3.21	2.61	1.513	1.406	2.93
6	4.28	3.58	0.996	1.365	4.08
7	3.77	2.87	1.254	1.253	5.4

Table 3.8 continues

Stat. no.	Mean		SD		t-value
	UPPER	LOWER	UPPER	LOWER	
8	3.29	3.15	1.328	1.266	0.76
9	3.73	3.41	1.262	1.319	1.65
10	3.59	3.61	1.224	1.23	-0.17
11	4.13	3.42	1.134	1.319	3.9
12	3.93	2.96	1.241	1.456	4.87
13	4.64	3.81	0.894	1.152	5.5
14	3.26	2.98	1.447	1.456	1.42
15	3.5	3.13	1.521	1.346	1.8
16	4.32	3.65	0.909	1.218	4.45
17	3.46	2.46	1.329	1.283	4.88
18	4.1	3.81	1.078	1.178	1.75
19	3.48	3.02	1.337	1.341	2.55
20	3.63	3.33	1.368	1.393	1.42
21	4.78	3.93	0.705	1.265	5.69
22	3.88	3.39	1.148	1.238	3.07
23	4.52	3.08	0.998	1.39	8.61
24	4.28	3.13	1.064	1.397	6.27
25	3.47	2.89	1.141	1.286	3.27
26	3.59	3.21	1.173	1.387	2.13
27	3.81	3.08	1.080	1.236	4.67
28	3.63	3.15	1.276	1.306	2.56
29	4.08	2.98	1.316	1.435	5.35
30	3.66	3.02	1.485	1.449	3.26

Table 3.8 continues

Stat. no.	Mean		SD		t-value
	UPPER	LOWER	UPPER	LOWER	
31	4.3	3.37	1.36	1.361	5.27
32	1.81	2.12	1.080	1.057	-2.07
33	4.56	2.85	0.946	1.403	10.88
34	3.10	2.47	1.514	1.306	3.00
35	4.47	3.02	0.958	1.421	8.87
36	4.38	3.90	1.003	1.087	3.13
37	3.80	3.01	1.318	1.251	4.26
38	4.791	3.72	0.624	1.223	7.53
39	3.83	3.58	1.198	1.156	1.27
40	3.43	3.01	1.423	1.322	2.26
41	3.59	3.11	1.498	1.355	2.37
42	4.20	3.36	1.025	1.267	5.33
43	4.10	2.68	1.150	1.413	7.80
44	3.32	2.99	1.384	1.299	1.64
45	2.64	2.27	1.514	1.179	1.89
46	4.12	3.11	1.192	1.385	5.23
47	4.02	2.73	1.189	1.270	7.64
48	4.10	3.10	1.267	1.432	5.10
49	4.47	2.65	0.989	1.274	11.30
50	4.14	3.34	1.064	1.335	4.71
51	4.37	3.19	0.960	1.361	7.66
52	3.43	2.84	1.409	1.412	3.08

Table 3.8 continues

Stat. no.	Mean		SD		t-value
	UPPER	LOWER	UPPER	LOWER	
53	3.60	3.07	1.318	1.289	3.05
54	3.74	3.03	1.522	1.480	3.55
55	3.59	2.60	1.393	1.287	5.35
56	4.37	2.70	1.269	1.374	9.66
57	4.88	3.93	0.327	1.112	8.40
58	4.23	3.39	0.863	1.238	5.47
59	3.08	3.00	1.398	1.435	0.35
60	4.08	3.26	1.236	1.419	4.89
61	3.31	2.69	1.405	1.285	3.08
62	3.20	2.60	1.435	1.378	3.13
63	3.76	2.81	1.436	1.354	4.76
64	2.39	2.38	1.421	1.277	0.05
65	3.71	3.13	1.289	1.228	3.18
66	3.34	2.79	1.387	1.274	3.26
67	3.37	3.00	1.253	1.318	2.16
68	4.66	3.71	0.714	1.250	6.92
69	4.44	3.37	0.820	1.212	7.11
70	1.79	2.15	1.175	1.149	-2.30
71	3.52	2.73	1.527	1.262	4.35
72	3.46	2.74	1.487	1.411	3.38
73	3.61	3.11	1.238	1.385	2.84
74	3.95	3.40	1.218	1.214	3.21
75	4.12	3.19	1.037	1.323	5.56

Table 3.8 continues

Stat. no.	Mean		SD		t-value
	UPPER	LOWER	UPPER	LOWER	
76	3.46	3.54	1.403	1.267	-0.42
77	4.62	3.51	0.896	1.367	6.96
78	4.55	2.98	0.947	1.348	10.43
79	4.04	2.72	1.197	1.198	7.97
80	3.24	3.25	1.571	1.395	-0.04
81	2.77	2.74	1.427	1.284	0.15
82	3.40	3.09	1.181	1.256	1.83
83	4.15	3.14	1.058	1.393	6.02
84	4.24	3.00	1.065	1.231	7.65
85	3.80	2.77	1.407	1.377	5.38
86	3.71	2.79	1.499	1.380	4.87
87	4.11	2.70	1.154	1.283	8.44
88	4.59	3.83	0.996	1.164	4.76
89	3.41	2.86	1.478	1.400	2.72
90	4.62	3.86	0.874	1.128	5.10

For the selection of statements for the final format of SAS, the following criterion as suggested by Likert (1932) was followed :

"The value of t is a measure of the extent to which a given statement differentiate between the high and low groups. As a crude and approximate rule of thumb, we may regard any 't' value equal to or greater than 1.75 as

indicating that the average response of the high and low groups to a statement differs significantly, provided we have 25 or more subjects in the high and also in the low group."

From the table 3.8 it is evident that statement No.1,2,4,8,9,10,14,20,32,39,44,59,64,70,76,80 and 81 did not satisfy the above mentioned criterion given by Likier (1932) and there by they were rejected at the first sight. With this rejection of statements, seventy three statements remained out of which thirty five were positive and remaining thirty eight were negative polarity statements. Though the 't' value of statement No.18 is 1.75, it was also rejected because by doing this the total number of the statements, and the number of positive polarity statements would be an even number. This facilitated the splitting of all the remaining statements in to two groups for the purpose of estimating reliability coefficient. Thus, in all a total of eighteen statements were rejected, and the remaining seventy two statements were selected.

#### **3.11.1.13 The Final Format**

The final format of SAS contained seventy two statements out of which thirty four were of positive polarity and thirty eight were of negative polarity. The

distribution of statements as achieved after item analyzes on different components was as follows :

**Table 3.9**

**Distribution of statements on the final form of the scientific attitude scale.**

Components	Statement Number with		Total number of statements
	Positive Polarity	Negative Polarity	
Rationality	8,12,22,30,42,47 (6)	1,2,4,33,39,57,65,67,68,69 (10)	16
Curiosity	9,16,18,19,38,41 (6)	6,24,27,48,50,58,63 (7)	13
Openmindedness	11,31,51,53,59,64 (6)	23,29,32,35,36,44,49,52,71 (9)	15
Intellectual Honesty	5,7,28,54,60 (5)	10,14,15,43 (4)	09
Observation	3,34,46,55 (4)	20,40,66 (3)	07
Environmental Awareness	13,17,26,45,61,70,72 (7)	21,25,37,62,56 (5)	12
Total	(34)	(38)	72

The scoring procedure for the statements of positive polarity was as follows:

For SA response 5,

For A response 4,  
For UD response 3,  
For D response 2,  
For SD response 1.

The scoring procedure for the statements of negative polarity was as follows:

For SA response 1,  
For A response 2,  
For UD response 3,  
For D response 4,  
For SD response 5.

This format is enclosed vide Appendix- IV.

#### **3.11.1.14 Psychometric properties of the developed scale**

Determining the validity of the developed scale involved two methods namely, Logical validity and factorial validity. The details with regard to each follows:

##### **Logical Validity:**

Logical validity of the developed scale was established. At the outset, all the accumulated knowledge on the construct was critically studied and on the basis of this, the components which constitute the construct were identified. The identified components were defined

by specifying the universe of behaviours which may describe the construct. Such identified components of the construct and universe of behaviours of each of the components were referred to experts for their reactions. Incorporating the suggestions of experts, the construct was operationalised, Following this, a pool of statements representing each one of the components identified 'to constitute scientific attitude were developed. These statements alongwith specifications of behaviours which may be sampled under the components and specific directions for making the judgments regarding the representativeness of the statements developed, acted as the guideline against which judgements were made by competent persons. On the basis of the opinions and suggestions and discussions with competent persons, suitable modifications were brought in the format.

#### **Factorial Validity :**

Garrett (1959), describes it as, "In the statistical method called factor analysis, the inter correlations of a large number of tests are examined and if possible accounted for in terms of a much smaller number of more general 'factors' or trait categories. The factors presumably run through the often complex abilities measured by the individual tests. It is sometimes found, for example , that 3 or 4 factors will account for the

inter-correlations obtained among 15 or more tests. The validity of a given test is defined by its factor loadings - and these are given by the correlation of the test with each factor. A vocabulary test, for example, may correlate 0.85 with the verbal factor extracted from the entire test battery. This coefficient becomes the test's factorial validity."

In the present study, as scientific attitude is operationalised as the construct constituting of different components which may become the factors of the SAS. To estimate the factorial validity, the SAS was administered on 200 students during December 1995. Data from the administration were analysed to estimate the factorial validity. The results are summarized in the table 3.10.

Table 3.10  
Distribution of coefficient of correlation within  
components of the scientific attitude scale.

Components	Scientific Attitude Scale (Complete)	Rationality	Curiosity	Open mindedness	Intellectual Honesty	Environmental Awareness	Observation
Scientific Attitude Scale (Complete)		0.8328	0.8064	0.8477	0.8277	0.8565	0.7443
Rationality			0.5943	0.6056	0.6124	0.6215	0.5494
Curiosity				0.6203	0.6293	0.6078	0.5544
Openmindedness					0.6263	0.6886	0.5544
Intellectual Honesty						0.7000	0.5741
Environmental Awareness							0.6037
Observation							

The coefficient of six components of scientific attitude scale were ranging from 0.7443 to 0.8565. These high coefficients reflect the strength of each component

for measuring the scientific attitude. These coefficient also justify the inclusion of these dimensions in the scientific attitude scale.

#### Reliability :

The reliability of the developed scale was estimated by split-half technique as

- \* it is possible to measure reliability from a single administration of one form of a test.
- \* it requires only one form of a test, there is no time lag involved, and the same physical and mental influences will be operating on the subject.
- \* it was not possible to repeat the test itself owing to changes in the attitude of subjects upon taking the test second time.

The reliability of Scientific Attitude Scale (SAS) as calculated by split-half method was found to be 0.9131. The test was first divided into two equivalent halves by considering the following criteria :

1. Statements related to each component of scientific attitude were distributed evenly.
2. Statements with positive and negative polarities were distributed evenly.

3. In case of total number of statements being odd. with respect to component and/or polarity, they were distributed keeping in mind the particular behaviour which was to be measured by them.

While distributing the statements on the basis of above specific criteria, their comparability was also ensured. The distribution of statements into two halves is shown in the following table.

**Table 3.11**

**Distribution of statements of the scientific attitude scale into two halves.**

	First Half	Second Half
Statement Number	1,3,4,5,6,8,9, 10,11,13,15,16, 19,20,21,22,26, 27,28,29,32,36, 37,39,41,42,46, 49,50,51,59,61, 62,65,68,71	2,7,12,14,17, 18,23,24,25, 30,31,33,34, 35,38,40,43, 44,45,47,48, 52,53,54,55, 56,57,58,60, 63,64,66,67, 69,70,72
Total	36	36

From the reliability of the half test, the self correlation of the whole test was then estimated by the Spearman - Brown Prophecy formula. The correlation coefficient for the half-test was 0.8401. The very high value of (0.9131) of the reliability coefficient of the whole test may be attributed to the:

- \* Likerts' technique of scale development,
- \* length of the scale Garrettee (1959), suggests that, "the longer the test the less probability that effects of temporary and variable disturbances will be cumulative in one direction, and the more accurate the estimate of score reliability.

#### 3.11.1.15 Fixing the Norms

After any tool has been carefully administered and painstakingly scored, the results must be appraised and translated into information helpful to the individual tested.

A test score is meaningful if it is properly understood. A score on a test is given meaning by referring it to some group average. A yardstick is, therefore, required to measure the magnitude of the deviation of an individual's score from the general population average, or from the average of one's group. A

table of norms shows the range of the scores others have made and the way these scores are distributed. A norm is a standard of reference, so a table of norms serves as yardstick.

It is generally recognised that valid norms are essential for dependable interpretations of individual and group measures. In fact, our very language of thinking, involving and requiring such terms as "little", "much", "typical", etc. imply the recognition of norms. It is obvious, then, that norms are of basic importance.

Norms provide the user of a standardized test with the basis for a practical interpretation and application of the results. The terms "norms" and "standards" are frequently used interchangeably and the confusion arises over the fact that norms are used with standard test and that part of the process of standardization is the fixing of norms. It is, therefore, necessary at the outset to distinguish clearly between a norm and a standard. Greene et.al. (1955), point out the difference between a norm and a standard as, "The term standard, when used to refer to a level of pupil achievement implies an ultimate goal to be achieved, while norms are the levels of achievement which typical pupils actually attain.

In the present study, for the scientific attitude scale which was constructed for the students of Std.X of Baroda District, the following norms were derived.

1. Percentile norms
2. Gender Norms
3. Area Norms.

For the purpose of deriving these norms, the mean, standard deviation, median, percentiles, skewness and kurtosis of the entire sample (N=200) were computed. On the similar line all the above mentioned measures were computed separately for the boys (N=098), the girls (N=102), the urban students (N=100) and the rural students (N=100). The results are presented in the table 3.12.

Table 3.12

Mean, Standard Deviation, Skewness, Kurtosis and Percentiles of Scientific Attitude Score of the Students.

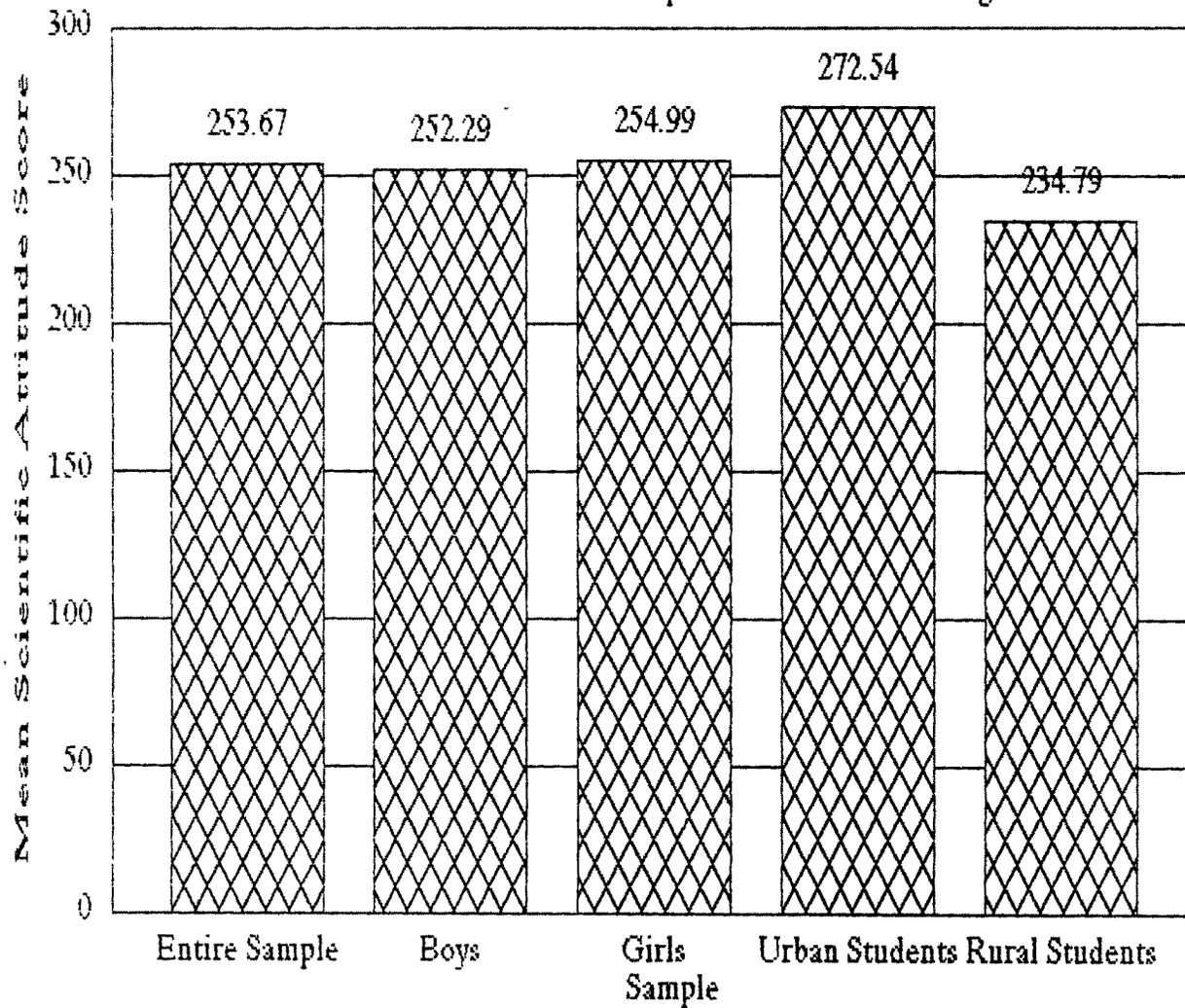
	All the Sample	Boys	Girls	Urban Students	Rural Students
Mean	253.67	252.29	254.99	272.54	234.79
SD	34.9695	35.5579	34.3424	29.1906	29.6834
Median	258.00	244.00	262.00	277.00	224.00
P 10	212.00	213.00	212.00	222.00	210.00
P 20	217.00	216.60	219.40	259.00	214.00
P 30	223.00	222.40	226.20	269.00	214.00
P 40	231.00	227.20	234.40	273.00	221.00
P 50	258.00	244.00	262.00	277.00	224.00
P 60	273.00	272.00	273.20	281.00	228.00
P 70	278.00	277.00	278.40	288.00	232.00
P 80	288.00	288.40	286.60	293.00	247.00
P 90	300.00	297.60	299.40	306.00	282.00
Skewness	-2.000	11.30	-6.30	-13.00	22.00
Kurtosis	0.3409	0.3723	0.3347	0.1429	0.1667
	*	*	*	**	**

\* Platykurtic

\*\* Leptokurtic

**Figure 3.5**

Mean Scientific Attitude of Sample taken for Establishing Norms.



The lowest score obtained on scientific attitude scale was 191.00 and the highest score was 326.00. It was found that 89 students (44.50%) hold low scientific attitude i.e. their scientific attitude score was less than 237.00, the scientific attitude score of 61 students (30.50%) was between 237.00 and 281.00 i.e. (30.50%) of the students hold average scientific attitude and the scientific attitude score of 50 students (25.00%) was more than 281.00 i.e. only 25.00% of the students hold high scientific attitude (see figure 3.5).

From Table 3.12, it is observed that the students hold average scientific attitude. The scientific attitude of girls is more than that of boys. The difference between the mean scientific attitude of urban and rural students is more. The scientific attitude score of 50% of urban students was upto 277.00 whereas that of rural students was only 224.00.

#### 3.11.1.16 Using the Norms

The norms established in the present study may be applied in comparing the possession of scientific attitude of any other student selected from the population. The individual student can be placed in a particular group and from this it can be judged how far an individual has been able to possess scientific attitude.

### 3.10.2. Tool to Measure Socio-Economic Status.

Keeping in mind certain limitations, the investigator decided to rightly select the tool to measure socio-economic status of students from already standardized tools available in the field of study.

In many educational, psychological, sociological, economic, political, labour welfare and health researches, the social and economic status of individuals affect their behaviour and so socio-economic status (SES) has been recognized as an important variable in such researches. Many scales have been developed in the West and also in India from time to time to assess the SES of individuals. This is because the social and economical background of different individuals go on changing with changes in the homes of people, in the vehicles they use, in communication and recreation facilities and also in the economic condition. Industrialization, urbanization and many other developments in India bring about these changes. Secondly, India being a vast country, there are many social, cultural and economical variations and the indices of SES in one place may be quite different from those elsewhere.

The SES of a family is determined by a number of determinants like income, education, occupation, culture, type and location of house, etc. A study of single factor

does not give an adequate picture of family. In India, a number of scales are available measuring different factors of home.

After a thorough survey of literature, the investigator identified the following scales on socio-economic status of students which were found to be useful primarily. They include.

Kuppuswami's (1962) SES Scale,  
Verma's (1969) SES Scale,  
Srivastava's (1978) tool,  
Rao's (1982) SES scale and  
Desai's (1987) SES scale.

Kuppuswami's (1962) SES Scale developed on the basis of three factors, namely, education, income and occupation is meant for urban population. But as it did not mean for rural population also, it was not found useful for the present study.

Verma's (1969) SES Scale includes factors like the compositions of the family members, social position of family members, relatives and the attitude of the family towards social practices. But, it is strange that important factors like occupation and education of parents have not been included in the scale. Therefore,

this scale also was found to be less useful for the present study.

Srivastava's (1978) tool seeks informations on five important factors, viz., education, occupation, income, culture and social participation of the family. This tool seemed to be useful but there was one practical problem. The occupational list employed is very lengthy and has 70 job titles. It is time consuming and very difficult for the students to go through such a lengthy test.

Rao's (1982) SES scale includes the education of parents and the eldest brother sister, income, occupation of parents and the eldest brother or sister and culture of the family. Though this is fairly comprehensive scale, the informations on three factors viz. education, income and occupation is seemed from eldest brother or sister alongwith that of parents. Many respondents of the sample may be the eldest child in the family whereas the other respondents may not be. This may lead to uneven loading of these three factors in the total score.

Apart from these, all the above mentioned four scales viz., Kuppaswami's (1962), Verma's (1969), Srivastava's (1978) and Rao's (1982) were developed before more than a decade. Hence, the income slab of them may be unrealistic in the present day.

From among the SES scales described above Desai's (1987) scale found to be more suitable for the present study mainly due to the following reasons.

- it is the recent SES scale which the investigator could locate.
- it took into account six factors viz. Caste, Vocation, Education, Income, Type of residence and Vehicle of the family, which are the major indices of SES.
- the reliability and validity of the scale is also high.
- it was standardized on the urban, semi-urban and rural sample of Gujarat State.

Desai's (1987) SES scale was developed by including factors like Caste, Vocation, Education, Income and type of residence and vehicle of the family. These factors are described below.

**Caste :**

Although Caste has been discouraged as an attribute of one's background, it is still a very potent factor in the social life in India. Caste is considered an important factor in marriage, vocational selection, lifting of

residential premises, social participation and even in general election. Sub-caste barriers are fast disappearing, but the main castes are still considered an important factor of an individual's social background. Caste also includes religion to some extent as in Jains. As given in the Appendix- V, Caste groups were divided into levels 1 to 6 and were assigned marks in an ascending order.

**Vocation :**

Different groups of vocations have been graded from 1 to 5 according to the skill and training needed of the personnel. This gradation has been influenced by the one used in the Dictionary of occupational Titles (Fourth Ed. 1977, Supplement 1982) of the USA and also of the National Classification of Occupations in India(1968).

**Education :**

Education of father or guardian is considered an influencing factor, because the vocational choice and the consequent income of the family are dependent on it. Mother's education does influence the upbringing of the child, but it is still not a potent factor in the social status of the family.

**Income :**

Although income of a family is the main factor to determine the living condition of the family, young children hardly know their father's income from all sources exactly. Therefore ranges of monthly income are given in the scale so that the respondent can find out the one applicable to his/her family.

**Type of Residence :**

A hut or a room or a block determines the economic level of the family more or less. Therefore, the type of residence has to be taken into account for determining the SES of a family.

**Vehicle :**

The type of vehicle that the family possesses has direct relation with its economic level. Some families may possess, a scooter and a motorcar simultaneously, but the highest type is to be taken into account by the respondent.

The test-retest reliability of the scale was 0.82 for Urban, 0.96 for semi-urban and 0.81 for rural sample. The concurrent validity of the scale determined by finding out the contingency coefficient between the scores on the SES scale and teachers' opinion about their SES was 0.63

for urban sample and 0.83 for rural sample considering that the teachers' opinions are usually approximate. The coefficient of contingency which is also an approximation of the coefficient of correlation is quite good.

However, it was not found to be more suitable as it was to be used in 1995-96 which hampers the reliability of the score obtained by it. The scale was developed in 1986-87 and by 1995-96 the value of money has deflated. To take care of money deflation, the aspect of income was updated. The formula for updating the income from Desai (1987), original scale was as follows:

$$\text{Original Income group of Desai} \times \frac{\text{Urban non-manual cost of Index for 1994-95}}{\text{Urban non-manual cost of Index for 1986-87}}$$

Source: Booklet of Central Statistical Organisation, 1994.

Desai's (1987) SES scale is in English language which was translated into Gujarati as the sample for the present study comprises of students who were studying in Std. X of the Gujarati medium schools of Baroda. For the Validation of translation, it was referred to two experts in Gujarati language from the department of Gujarati, Faculty of Arts, The M.S.University of Baroda, Vadodara

and to two Gujarati Language expert teachers from the schools of Baroda City.

For all the items in the scale, predetermined responses were worked out and the respondents were supposed to put tick mark " ✓ " against the appropriate responses applicable to them.

### 3.12 COLLECTION OF DATA

The procedure of data collection for the present study was carried out in two phases, the details of which are described below :

#### 1. Phase : I

During this phase, the data pertaining to variables scientific attitude score, socio-economic status and gender of students were collected from all the students of Std. X who were studying in the selected schools which comprise the sample. For this, initially the principal of all the selected schools were consulted to seek their permission to collect the data and were informed that the investigator would visit their school on any working day between 1st to 13th January, 1996. Accordingly, the investigator went to each of the selected schools personally and met the principal during January, 1996. Then, the investigator had administered the

tools to all the students of Std. X who were present on that day in the respective schools to obtain the data.

Prior to administration of both the tools viz. Scientific attitude scale and SES scale, the students were made aware about the purpose of administration of the tools and were given the following instructions regarding the tools and the expectations from them when they provide responses.

Instructions for Scientific attitude scale :

- the Scientific attitude scale contains seventy two statements which represent hypothetical situations.
- you might have come across these situations or may come across them in future.
- against each of the statements, five options viz. strongly agree, agree, undecided, disagree and strongly disagree are given.
- read each of the statement carefully and put a tick mark " ✓ " against any one of the five options applicable to you.
- they were made very clear about their responses which should be based on what they belief, how they have believed/behaved or how they will

behave when encountered or will encounter such situations which were contained in Scientific attitude scale and they should not react keeping in mind how they should behave or what they should believe.

- they were made clear about the difference among the five options giving illustrations.
- they were informed that these are the hypothetical situations and you are expected to express your belief, there is no correct or incorrect answer to any of the statements.
- they were advised not to see the responses given to the statements by their friends as the belief towards a particular object/phenomenon/situation varies from individual to individual.
- they were requested to provide their responses to all the seventy two statements.

Then, they were asked to read the printed instructions on the first page of scientific attitude scale. They were informed to ask the investigator whenever they find any word or statement difficult to comprehend. They were also informed that this is not a time bound test and hence read each statement carefully and respond according to your own belief.

The students were asked to write their complete name, specify the gender, name of the school and the address of school against the space provided for it. After completing such introductory formalities, the students were allowed to provide their responses to statements in Scientific attitude scale.

Majority of the students were able to complete their responses to Scientific attitude scale within 75 minutes. The students were once again reminded to ensure that they have responded to all the seventy two statements of the Scientific attitude scale. The investigator also ensured the complete response to all the seventy two statements of the Scientific attitude scale by randomly checking a few of them while collecting the duly filled in SAs from the students.

Then, the students were given the SES scale and were made aware about the importance of SES in the present study. By then, a good rapport was established between the investigator and the students. Then, the following instructions for SES scale were given.

They were advised to provide correct informations about their family on different factors like caste, vocation education, income, type of residence and vehicle. The students were informed to take help of the

investigator whenever they face difficulty. They were instructed to put a tick mark " ✓ " against the applicable column to their family for the categories under each of the factors of SES scale. They were instructed to provide instructions for all the factors.

They were asked to write their complete name, gender, parents educational qualification, caste on the first page of SES scale and then provide the rest of the informations.

Majority of the respondents were able to provide the informations on SES scale within 20 minutes. At the time of collecting the duly filled in SES scale, it was ensured by the investigator that the students have provided the complete informations.

The students were guaranteed about the confidentiality of the informations collected and about its use only for research purpose.

## 2. Phase – II :

During this phase, the data pertaining to variables general achievement and achievement in science of the students were collected from the respective schools record during the period of July to August, 1996.

The Principal of the selected schools were consulted by the investigator and the data pertaining to general achievement and achievement in science of all the students who were earlier administered Scientific attitude scale and SES scale were collected from the schools' records.

The marks obtained by each of the students in all the five compulsory subjects viz. Higher level Language (Gujarati), Lower Level Language (Hindi or English), Mathematics, Science and Social Studies were copied from the schools' record. These are the marks obtained by students in the respective compulsory subjects on the examination conducted by Gujarat Secondary Education Board, Gandhinagar (Examination Wing - Vadodara) during March, 1996. The marks obtained by students indicate their academic achievement in different compulsory subjects out of the maximum marks of 100 in each subject. The set of question papers on which students had obtained their scores, are given in Appendix- VI.

General achievement of each student was calculated by finding an average of the marks obtained in the five compulsory subjects. Achievement in Science of each student was directly available from the above collected data.



### 3.13 DATA ANALYSIS

Thus collected data were analysed through appropriate statistical techniques. To study the distribution of scientific attitude of students Mean, SD, Percentiles, Skewness, and Kurtosis were computed for the entire sample, the boys, the girls, the urban students, and the rural students. To study the relationship between scientific attitude score and other variables viz. SES score, achievement in science, general achievement, Pearson's product-moment correlation technique was applied. To study the difference in the scientific attitude score with other variables, ANOVA was applied.

The entire programme of the present piece of research, presented in this chapter provides a clear cut direction for the work and thus sets the stage for analysis. Such an analysis would lead to churning out the cream of the work. In other words, what is the level of scientific attitude possessed by the secondary school students of Baroda and how far scientific attitude is related to other variables can be seen the data analysis. This is the subject matter for the foregoing chapter.