CHAPTER - III

METHODOLOGY
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The general principle of research, as in this case, is to establish adequate relationship within a set of variables. For this purpose, one is to select a set of variables at the beginning which may have some probable relationship within themselves and to formulate the hypothesis. Then the researcher is required to select a sample representative enough for a well-defined population to collect relevant information in the form of data and to test the hypothesis with various tools and techniques to arrive at the conclusions. For this reason, the present chapter has been divided into the following sections so as to delineate step by step the entire plan of research.

3.1. Selection of variables

3.2. Hypothesis

3.3. Sampling

3.4. Selection of tools

3.5. Description of the tests

3.1. SELECTION OF VARIABLES AND HYPOTHESIS

In the present study the major objective had been to study the environmental factors, academic achievement and aptitude factors that may have some impact on the determination of pupils' attitude towards science. The ultimate objective is to throw light on the way, how the attitudes towards science subjects are formed in young children upto the level of adolescents. Thus attitude towards science is the dependent variable for this investigation and the independent variables selected belong to three categories, namely, environmental factors, achievement factors, and aptitude factors.

3.1.1. Environmental factors

There may be two types of environmental influences in respect to the development of attitudes. In the one form of influence, the social environment and its various agents may impart some direct instructions to the individual concerned in favour of developing a specific pattern of attitudes. As for example, the teachers, parents, private tutors, peers, and such other persons in the family and outside may directly try to inculcate a favourable attitude towards science. In another
form of influence, the individual, through the encounter of various environmental conditions, the interpretation given to the environmental conditions on the basis of his personal predispositions, its demands etc. may develop certain attitude patterns. As for example, if an individual perceives that high esteem is assigned by the society to the science and it is one of the most prestigious ways of self actualization, he may develop positive attitude towards science.

Considering these facts, individual attitudes may be supposed to be influenced by his surroundings, parent's education, family size, income of the family, representing his socio-economic status, influence of peers, influence of teachers, vocational value of science and a host of other such variables. A set of pertinent factors as mentioned above and taking into account both the types of influences mentioned, have to be selected with a view to find which of these do really determine attitude towards science.

3.1.2. Achievement factors

As individual's attitude towards science may be formed through his experience of success and failure in the courses of study he is undergoing, his achievements in school subjects are to be selected as one important set of variables for the
study. For this purpose, a careful examination of the school subjects and their probable impact on the attitude formation had to be considered.

It was noted that the curriculum of the present day secondary schools in West Bengal is oriented to impart lessons on the following categories of subjects:

A. **Language** - Includes mother tongue and one second language (English in most of the cases)

B. **Physical Sciences** - Includes mathematics, physics, and chemistry.

C. **Life Science** - Living environment including its relation with human body and life.

D. **Social Studies** - Includes the history, Geography, and the economical aspects of environment.

E. **Work education** - Orientation towards manual labour through handicrafts or other productive jobs.

Examination of the specific course materials revealed that the last group, (i.e., the work education) had hardly any scope of influencing one's attitudes. Therefore, it was planned to consider the achievement in the remaining four areas for testing their impact on the attitude towards science.
3.1.3. **Aptitude factors**

Aptitude may be defined a condition symptomatic of a person's fitness, of which are essential aspect is his readiness to acquire proficiency - his potential ability and another is his readiness to develop an interest in exercising his ability. It is expected in the present study that presence or lack of aptitudes in science subjects, that is individual's estimation of his own potentialities may influence his attitude towards science. There are many aptitudes, among them student's numerical ability, mechanical reasoning, spatial visualization, and abstract reasoning are considered as scientific aptitudes from the study of relevant literature. Lewis (1964) administered numerical and spatial in the study of student's attainment in elementary science. Deb (1969) showed that numerical ability and mechanical reasoning were two important factors for high achievement in natural science. It may be expected that student's estimation of his own scientific potentialities may influence his attitude towards science.
Thus, the set of variables selected for this investigation may be summarized below:

Table 3.1

Variables selected for the study

<table>
<thead>
<tr>
<th>Category of variables</th>
<th>Specific variables</th>
<th>Relation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Attitude towards science</td>
<td></td>
<td>Dependent variable</td>
</tr>
<tr>
<td>2. Environmental factors</td>
<td>1. Parent's education</td>
<td>Independent variables</td>
</tr>
<tr>
<td></td>
<td>2. Parent's occupation</td>
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<td></td>
<td>3. Socioeconomic status</td>
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<td></td>
<td>4. Influence of teachers</td>
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<td></td>
<td>5. Influence of peers</td>
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<td></td>
<td>6. Vocational value of science</td>
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<tr>
<td>3. Achievement factors</td>
<td>1. Achievement in Language.</td>
<td>Independent variables</td>
</tr>
<tr>
<td></td>
<td>2. Achievement in physical science</td>
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<td></td>
<td>3. Achievement in Life science</td>
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</tr>
<tr>
<td></td>
<td>4. Achievement in social study</td>
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<tr>
<td>4. Aptitude factors</td>
<td>1. Numerical ability</td>
<td>Independent variables</td>
</tr>
<tr>
<td></td>
<td>2. Mechanical Reasoning</td>
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<td></td>
<td>3. Space Relation</td>
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</tbody>
</table>
3.2. **HYPOTHESIS**

A research starts with the formulation of a problem. The researcher expresses a tentative solution to that problem. Following the statement of a hypothesis, the researcher seeks to determine whether the hypothesis may be accepted or rejected. Hence, the tentative explanation as the beginning step in enquiry is known as hypothesis. The tentative suggestion directs the search for corroborating or negating facts. Then the investigation is designed which involves a direct analysis of all major conditions of hypothesis. Researchers use hypothesis to deal with unobservable events or unobservable relationships.

The hypothesis drawn up for the present study may broadly be stated as follows:

There is no significant difference between the pupils having highly positive attitude towards science and having highly negative attitude towards science in respect of any of the independent variables mentioned in the table 3.1 either in isolation or in interaction.

3.3. **SAMPLING**

One of the important steps towards testing the hypothesis is the selection of individuals with whom to work. Adequacy of hypothesis testing depends upon proper
sampling. A sample is any subgroup or subaggregate drawn by some appropriate method from the population. A sample consists of limited number of individuals out of entire population. The method used in drawing the sample is important in testing the hypothesis. There are various techniques of sampling which will be discussed with their relative merits and demerits.

3.3.1. Random sampling -

The best definition of random sampling is that it is selection of cases from the population in such a manner that every individual in the population has an equal chance of being chosen. In addition, the selection of any one individual is in no way tied to the selection of any other. A random sample should be fairly representative of the population though in any particular sample, if it is a small one in particular, by chance it may not be so representative as we would like.

3.3.2. Biased sampling -

In a biased sample there is a systematic error. Certain types of cases have an advantage over others in being selected. The scientific investigator must be eternally vigilant to the possibility of biased sampling. A good, systematic control of
experimental conditions is designed to prevent biased samples or to make known their effects. Where there is less than customary experimental control of observations, every possible effort should be made to know the conditions under which the data are obtained. Through knowledge of the conditions should be a basis for deciding whether selection of cases has been biased.

3.3.3. **Stratification of sampling**

One common procedure that is introduced in sampling to help to prevent biases and also to ensure a more representative sample is known as stratification. Stratification is a step in the direction of experimental control. It operates with subgroups of more homogeneous composition within the larger population. Subgroups of the population are considered with respect to any variable that is suspected of correlating appreciably with the variable being studied. Having decided which variables are important in sampling, the entire population is studied to see what proportions fall into each category. A stratified random sample is likely to be more representative of a total population than is a purely random sample.
3.3.4. **Purposive sample**

A purposive sample is one arbitrarily selected because there is good evidence that it is very representative of the total population. The sample is chosen in the light of available evidence. This is a convenient procedure, but it has the disadvantage that much prior information must have been obtained.

3.3.5. **Incidental sample**

The term incidental sample is applied to those that are taken because they are the most available. Results thus obtained can be generalized beyond such groups with considerable risk. Such casual groups rarely constitute random samples of any definable population.

3.3.6. **Selection of samples in the present study**

Among the various techniques which have been discussed above, a stratified sample appears to be most suitable for the present study. This procedure is applicable when the population is composed of sub-groups of different sizes, so that a representative sample must contain individuals drawn from each category or stratum in accordance with the sizes of the
groups. The most obvious stratification for the proposed sample is due to sex difference. The other sources of stratification may be the habit at which cater to the needs of the schools or in other words the socioeconomic conditions of the localities, the status of schools etc. All these sources of stratification are to be considered at the time of sampling.

As the present study deals with the pupil's attitude towards science, the sample must be selected from the students who are mature enough to have a definite attitude towards science. In our educational system, the students, reading in the top classes of a secondary school are said to have reached such a stage. The reasons are as follows -

**Age:** Age of the adolescents give them a new outlook by which they start developing stable attitudes not only towards the concrete objects around them but also towards abstract ideas and concepts. Science is a concrete course of study on the one hand, but at the other it is a kind of abstract concept which may govern to a large extent our attitude towards it. For this reason, adolescent group seems to be the most suitable sample for the present investigation. Again attitudes are learned as the result of experience (Johnson, 1988). During the school years, an individual gathers the experience of
adequacy and inadequacy in the particular subject, and his experience of the teaching process of the particular subject are gathered after studying the subject for several years. Thus, the effect of schooling on attitude formation may best be observed towards the end of the school days. From this point of view also the adolescents appear to be the suitable subjects for this study.

The point of diversification:

The students of adolescent stage reach the gateway of future planning about further higher studies as it is the transition period of education. They are to enter the higher secondary level from secondary schools and require to opt for this course of study or that. Thus, their likings and dislikings for different subjects and for different streams assume a permanent shape at this stage. Therefore, it is most likely that they would have already a stable attitude towards science either positive or negative.

Social impact:

During the adolescent stage the students are generally attracted to the glamour of science for their romantic nature. Moreover, they may have favourable attitude towards science
for their aspirations in gaining social approval. During this stage they are aware of the advancement of science in the world, the bright future of science may influence them. At the same time, at this very stage they develop more realistic attitude towards self. An individual is likely to assess his abilities more realistically and there may arise a conflict between the assessed self and the ideal self. Therefore, there is every possibility of having developed positive as well as negative attitude towards science in the adolescent mind.

Therefore, it seems that the students of class X of our secondary schools may form our population quite well. In the selection of the sample, three steps must be considered in this case –

a) **Selection of the students**

The students of both sexes must be selected. Efforts must be made to select the sample from different socioeconomic status, different parental educational level, and the students belonging to different locality. Thus, the population will be divided into different sub-groups or stratum.
b) Selection of schools

The schools, situated at the different regions of Calcutta, will be selected for the study. The schools will be of average, above average, and below average categories on the basis of the results in the final secondary examination and their reputation in the locality. In some schools, the students are classified into different sections according to their performance. Students will be selected always from the better section on the assumption that according to the standards of the schools the qualities of their students also can be considered to have been classified as above average, average, and below average levels.

c) Size of the sample

The size of the sample ideally, should depend upon the nature of the problem, the size of the population, and how the individuals are selected from the entire population. Single individual may be studied in the case of depth study. So it is not a matter of numbers, it is a matter of how the cases are selected (Guilford, 1956). The purpose of sampling are to reduce cost and time of large data-collecting operations, and to obtain the results more quickly, so the size of
the sample will not be too small or too large. As the present study deals with student's attitudes towards science and takes into account a good number of variables, so the sample will not be too large. Ormerod (1971) studied "social implication" factor in attitude towards science. He developed and administered a scale measuring attitude towards science to 261 male and 264 female English Secondary students. Sandis (1968) studied the influence of parents on student's educational plan. The sample for the study consisted of 524 tenth graders and their mothers. So the present study, aims to select around 500 students which may be considered sufficient for this purpose.

After the selection of the sample, next the researcher is to select the appropriate tools in testing the research hypothesis.

3.4. SELECTION OF THE TOOLS

Selection of tools depends upon the variables selected for the study, hypothesis to be tested, feasibility of administration, reliability and validity factors.

The two essential characteristics of a sound test are its reliability and validity. The reliability of a test
is its ability to yield a consistent results from one set of measures to another, it is the extent to which the obtained test scores are free from such internal defects as will produce errors of measurement inherent in the items and their standardization. Reliability has two closely related but somewhat different connotations in psychological testing. First, it refers to the extent to which a test is internally consistent, that is consistency of results obtained throughout the test when administered once. Secondly, reliability refers to the extent to which a measuring device yields consistent results upon testing and retesting.

An index of validity shows the degree to which a test measures what it purports to measure. Selection of satisfactory validation criteria and demonstration of an appropriate degree of validity are fundamental in psychological testing. Validity permits us to judge whether the test measures the right thing for our purposes.

Selection of test depends upon the variables selected for the study. A particular variable may be tested with different tests and tools, so some other factors must be considered in the selection of a test. Ease of application is an important thing in selecting a test. Time available for testing is always limited, therefore short tests are preferable
to serve the purpose of testing. Moreover, too long a testing period bores the subjects and makes them uncooperative. So, all of these factors must be considered in the selection of the tests for the measurement of variables.

3.4.1. Measurement of attitude

In the present study, pupil's attitude towards science is the dependent variable. As the sample for the present study are school students, so the attitude scale has to be selected carefully. The linguistic medium should be either English or Bengali that can be administered to the Bengalee school students. Study of relevant literature has shown that Bruvold (1974) studied pupil's attitude towards science by means of face to face interview. This time consuming method is not suitable in the present situation. Butall (1971) used science attitude scale, produced sub-scores on science interest, social implication of science, learning activities, science teacher's and schools but the result showed no consistent attitude towards science and arts. An attitude scale prepared by Grewal (1974) on the school students of same age range appears to be highly suitable for the present study. The norm of this scale is based on the students of the Indian schools. As the best type of test norms.
is a local norm based upon individuals in our school system (Downie, 1967). The scale is easier to administer and do not require a long period of time to complete the answering of test in comparison to questionnaire method administered by Kelly (1961). The reliability of the scale was estimated by the split - half (.86) and test - retest (.75) methods, which was found to be quite satisfactory. This science attitude scale appears to have content validity. Moreover this scale can be scored in a quite simple manner.

It is a Likert - type 5 point scale. The individual's score is the sum total of all his ratings on each of the items in the scale. The scale consists of 20 items to assess the attitude of individuals towards science. There is no time limit but normally it takes about 5 minutes to explain and the subjects require about 15 minutes for giving responses to items of the scale.

3.4.2. Measurement of achievement factors

Many investigators emphasized upon the relationship between pupil's academic achievement and attitude, as attitude is developed as a result of success or failure to achieve in a particular school subjects. There are varieties of achievement tests. But the administration of achievement test may
create some problems. The most important thing in the achievement test is to determine how well they meet the objectives of the local school. The vast diversities among the courses on the same subject, particularly at the high school level is well. Under these conditions, no external standardized test could suffice (Downie, 1967). So, in the present study attempts have been made to measure academic achievement by means of academic record. Meyer, Penfold, and Edward (1961) studied the factors associated with pupil's interest in science and science attainment was obtained from school examination mark. Passi (1971) used scholastic achievement scores in school subjects by taking aggregate marks, with regards to the reliability and validity of these marks, he has cited the study by Sharma (1968) who found these marks as valid and reliable indicator of school achievement. Duckworth and Butwistle (1974) used examination marks in the analysis of relationship between attitude towards school subjects and attainment.

In the present study, students marks in different school subjects will be collected from the school record on three successive examinations, this is likely to provide the researches with a consistent index of achievement. The average marks of three examinations will be considered as
the index of academic performance of the students. In the present examination system, all of the school subjects have been divided into different groups and group marks are considered to represent their performance. The detailed account of the groupings and their rationals have already been presented in an earlier section of this chapter.

3.3.3. Measurement of aptitude factors

An individual's aptitude for a given type of activity means the capacity to acquire proficiency under appropriate conditions. One may possess scientific aptitudes but motivation, determined by one's attitude and interest, may be the deciding factor in the selection of a course of study. Here a relationship may be expected between attitude and aptitude factors. Scientific aptitudes are composed of a combination of aptitudes. So, measurement of pupil's aptitude in science subject by means of a single test will not be quite appreciable. Chatterjee and Mukherjee (1969) used Mathematical knowledge and aptitude tests (MKA), scientific knowledge and aptitude (SKA) and Mechanical comprehension (MC) test to measure scientific aptitudes of the students. But, the administration of a single battery of tests has many advantages. A test battery is based upon unified and integrated plan. The product is a unified whole in which the parts fit together to cover the range of objectives. In the present study attempts will be made to
choose a battery of tests to assess the scientific aptitudes of school students. Descombes (1974) used FACT test of aptitude to find out the relationship between interest, aptitude, and academic achievement. But little evidence the validity of FACT is offered. Investigators have administered sub-tests of Differential Aptitude Tests to observe the relationship between attitude, aptitude, and achievement. Rodriguez, Feizoo, and Nelida (1978) measured aptitude in mathematics by Numerical Ability and Abstract Reasoning tests. Moreover, Differential Aptitude tests provide a well standardized procedure for measuring the aptitudes of boys and girls in administration and scoring ranked high among the requirements for the selection of a test, which the Differential Aptitude Tests were designed to satisfy. Its statistical data on standardization and analysis - reliability and validity, intercorrelation of parts, norms, population samples are exceptionally thorough. All of these factors have been considered in the selection of these tests in the present study.

As the present problem deals with the measurement of pupil's aptitude in science subjects, so three sub-tests of D.A.T. will be selected after studying the manual. The Mechanical Reasoning and possibly also Space Relations and Abstract Reasoning scores should be given attention, if one is
concerned chiefly with technical and scientific matter (Bennett, Seashore and Wesman, 1966). Moreover, prediction of Mathematics, physics and chemistry, engineering and other curricula, in which quantitative thinking is essential, numerical ability is required. Among these four sub-tests, tests of numerical ability, mechanical reasoning and Space Relation will be administered to the students with the necessity of shortening the time of test administration and to avoid the monotony of the students.

3.3.4. Environmental factors

The purpose of this study is to find out the environmental factors as determinants of pupil's attitude towards science. The factors selected for the study are family environment - parent child relationship, education and occupation of parents, and their leisure time activities, their economic status, teacher - pupil relationship, peer group influence and many other factors. Moreover, adolescents possess favourable attitude in considering the prestige, income and social recognition of scientific profession by the society. For the non-availability of a suitable test or information schedule, containing all the relevant information sought to be investigated here, an information schedule will have to be prepared.
The items of this schedule will be selected after a thorough survey of the literature which were mentioned in chapter 2 and on the basis of expert’s opinions. The science teachers of the different schools may be requested to describe the environmental factors having bearing upon the students’ attitude formation towards science, and the factors described by them should be included in the preparation of information schedule. The questionnaire will be prepared in Bengali, so that the students will give answers at ease. A standard format for such a type of information schedule will be adopted for framing the items and the response structures.

3.5. DESCRIPTION OF THE TESTS

The tests included in our study will now be described one after another.

3.5.1. Science Attitude Scale

The science attitude scale (Grewal 1974) is a self-reporting inventory consisting of 20 items designed to assess the attitude of individuals towards science. Each of the ten positive items of the scale are assigned a weight ranging from 4 (strongly agree) to zero (strongly disagree). In case
of ten negative items, the scale scoring is reversed ranging from zero (strongly agree) to 4 (strongly disagree). The attitude score of a subject is sum total of scores on all the twenty items of the scale. For each student a total score on the scale can be obtained by summating his scores for the individual items. Thus a maximum of 80 scores can be obtained by a subject. However, the administration of the test reveals that the scores ranged from 25 to 70. There is no time limit but generally it requires 15 minutes to administer. The raw scores can be converted into percentile norms.

The reliability of the Science Attitude Scale was estimated by the Split half (.86) and test-retest (.75) methods which were found to be quite satisfactory. This compares favourably with reliability (.77) found by Sood (1975) for his scale of attitude towards science and scientists. The scale appears to have content validity and the method of selecting items supports this supposition. In addition, differences in mean scores were found among the selected groups of known preference for science, i.e. Arts (mean = 46.41) and science (mean = 50.56) students
which is highly significant ($t = 6.62$) at .01 level. The scale was administered to 515 higher secondary students, the students were within the age of 15-19 years.

3.5.2. Aptitude tests

The Differential Aptitude tests was developed and standardized by Bennett, Seashore, and Wesman in 1947, to provide an integrated, scientific and well-standardized procedure for measuring the aptitudes of boys and girls in grades 8 through 12. The battery of Differential Aptitude Tests include 8 sub-tests, among them three sub-tests were administered as mentioned under section 3.5.3 in this chapter in the present study to measure scientific aptitudes of the students and will be described one after another:

3.5.2.1. Numerical Ability -

The numerical ability items are designed to test understanding of numerical relationship and facility in handling numerical concepts. The numerical ability test is a measure of the student's ability to reason with numbers, to manipulate numerical relationships, and to deal intelligently with quantitative materials. Educationally it is
important for prediction in such fields as mathematics, physics, chemistry, engineering and other curricula in which quantitative thinking is required. Various amount of numerical ability are required in professions related to the physical sciences. The items of the numerical ability test, call for understanding of numerical relationship; though computationally simple.

3.5.2.2. Mechanical Reasoning:

Mechanical Reasoning test consists of a pictorially presented mechanical situation together with a simply worded question. Care was taken to present items in terms of simple frequently encountered mechanisms that do not resemble text-book illustrations or require special knowledge.

The test is useful in those curricula and occupations where an appreciation of the principles of common physical forces is required. If a student intending to major in physical science field, or in technical, does not make a good score on this test, he should expect to find the work difficult. It is important to realize that Mechanical Reasoning scores are of less educational and vocational significance for girls than boys. The mean scores for girls are lower. If a girl expresses interest in mechanical or
engineering work, her score probably will be meaningful if compared with the scores of boys in her grade rather than with those of girls.

3.5.2.3. Space Relation:

The item type devised for the Space Relation test represents a combination of two approaches for the measurement of this ability. The ability to visualize a constructed object from a picture of pattern has been used frequently in tests of structural visualization. Similarly, the ability to imagine how an object would appear if rotated in various ways has been used effectively in the measurement of space perception. The item type used combines the functions of these item types, since both factors are considered important in any useful definition of ability to think in spatial terms. A feature inherent in these items is that they require mental manipulation of objects in three-dimensional space.

3.5.3. Information Schedule

Student's attitude is influenced by a number of environmental factors. As adolescent's family environment, school environment, peer group relationship, informations
from other sources are important in the formation of students' attitude towards science, so all of these factors will be included in the preparation of information schedule.

Besides the study of Literature, opinion were taken from science teachers from different schools of Calcutta regarding the factors which may influence students' attitude. Expert's opinion were taken from 7 experienced science teachers from different schools of Calcutta. The influencing factors, according to their opinion were vocational value or practical utility of science, parent's influence, sibling's influence, teacher's influence, private tutor's influence, glamour of science, regarding the recent advancement of science etc. The information schedule consisted of all of these factors and was prepared in Bengali version. The subjects can answer the items of the information schedule by marking 'Yes' or 'No' or by a tick-mark indicating his response.

The prepared information schedule, consisting of 40 items, was used at first for the pilot study. It was administered to 25 school students, while the information schedule was administered, it was observed that students were not able to understand 2 items as the language of these items were not properly framed, so these two items were modified in the
final form. While examining the responses of information schedule, the necessity of obtaining detailed information in respect of student's hobbies, planning of their career, their preferences for books, subjects taught by private tutor, was experienced by the researcher and hence four more specified items were added in the final form. Another five items were also included regarding the prestige of science in the society, vocational value of science, attraction of students to the practical side of science, scorability of science subjects etc. after surveying the relevant literature. Thus the final form of information schedule consisted of 49 items.

3.6. **STATISTICAL TREATMENT OF DATA**

Most of the psychological researches are aimed at finding relation among variables. Independent variables are manipulated by the researcher, to observe its effect on dependent variable. After the administration of tests, the quantitative specification of variables and their relationship are aided by means of proper statistical techniques. In the present study appropriate statistical measures must be taken to test the research hypothesis.
To describe the various aspects of empirical data, the first method of analysis will aim at the descriptive information of the sample. For this purpose, mean and median of the attitude, achievement, and aptitude scores will be computed. Standard deviation of the scores will be computed to serve a number of purposes. Particularly, it may be used to divide the subjects as high attitude and low attitude groups (similarly on other variables) in considering their scores above and below the range of mean $\pm \frac{1}{2}$SD, assuming a normal distribution of the scores. However, considering ultimately the actual nature of the distribution, in some cases, the variables may be dichotomized at the median point.

To observe the difference between males and females in aptitude, attitude, and achievement variables, the application of Fisher's $t$-test for large sample will be necessary. The $t$-ratio would reveal whether the difference between the two groups with respect to mean values is significant or not.

The main purpose of this study is to observe whether the student's favourable and unfavourable attitude towards science are related to environmental, achievement and aptitude factors. The nature of problem necessitates obviously a suitable multivariate procedure for analysing the data.
But all the data to be collected will not necessarily meet the requirements of score form. Data on the aptitude, achievement, and attitude variables will be in the score form. Data about the environmental factors are likely to be in the category form. Thus, any multivariate correlational analysis may not be appropriate enough to include all the categories of variables.

For this reason, the nature of relationship may be considered from the factorial point of view. The basic research question in that case will be: (1) whether there is any difference between two groups showing positive and negative attitude towards science in respect of their achievement, aptitude etc. (2) or, from another point of angle, whether the population in question differ in respect of their attitude towards science, if they are dichotomized into two groups considering certain environmental conditions, such as high socio-economic status and low socio-economic status and so on. Thus \( \chi^2 \) test in a \( n \times n \) contingency form appear to be most suitable mode of analysis under the circumstances.

Again, it is quite likely that the environmental, achievement, and aptitude factors do not operate upon the formation of attitudes in isolation, rather they play an
interactive role in attitude formation. Therefore, the question of interaction between more than one of the variables should also be considered here. Since a part of the data is in the score forms and the scores are most likely and at least ideally, distributed normally, Analysis of variance in a $2 \times 2$ or $2 \times 2 \times 2$ level may be adopted depending upon the final data set.

With the plan of research enunciated in detail in the above discussion, we can pass on to the next chapter which deals with the procedure of actual execution of the plan.