

# INTRODUCTION

## **CHAPTER I**

### **INTRODUCTION**

**1.1 Introduction**

**1.2 Values of Science**

**1.2.1 Intellectual Value**

**1.2.2 Utilitarian Value**

**1.2.3 Vocational Value**

**1.2.4 Cultural Value**

**1.2.5 Moral Value**

**1.2.6 Aesthetic Value**

**1.3 Impact of Science**

**1.3.1 Impact of Science on Agriculture**

**1.3.2 Impact of Science on Health**

**1.3.3 Impact of Science on Industry**

**1.3.4 Impact of Science on Modern Civilization**

**1.3.5 Impact of Science on Democracy**

**1.4 Objectives of Teaching Science**

**1.5 Scientific Attitude**

## CHAPTER I

### INTRODUCTION

#### 1.1 INTRODUCTION

It is difficult to write a short and simple definition of anything so complex as science. There are, perhaps, as many definitions of science as there are scientists. Generally accepted definitions of science are:

"Science is a cumulative and endless series of empirical observations which result in the formation of concepts and theories, with both concepts and theories being subject to modification in the light of further empirical observations. Science is both a body of knowledge and the process of acquiring it" (Frederic, 1996).

"Science is an accumulated and systematized learning, in general usage restricted to natural phenomenon. The progress of science is marked not only by an accumulation of fact, but by the emergence of scientific method and of the scientific attitude" (The Columbia Encyclopaedia, 1963).

From these two definitions three basic principles of the nature of science can be identified,

- (1) an accumulated and systematized body of knowledge,
- (2) the scientific method of inquiry, and,
- (3) the scientific attitude.

The first point indicates the 'PRODUCT' of science, while second and third points indicate the 'PROCESS' of science. Science, thus, is a combination of both processes and products, related to and dependent upon each other. When used in this way, science offers methods of inquiry useful in learning more about universe and its working. The processes of science are scientific attitude and scientific method of inquiry. As a result of these processes, one derives the products of science which are the accumulated and systematized body of knowledge.

Science is one of those human activities that man has created to gratify certain human needs and desires. Disinterested curiosity has been the greatest motive power of scientific research. The "Search of truth " became the dominant motive in the prosecution of science. It has been pursued for so many centuries and attracted ever-wider extent of attention of a very persisted group of people. Science is valued mostly for its practical advantages though it is also valued for gratifying disinterested curiosity and as an object of great aesthetic charm. It is quite obvious that most of

the people value science chiefly for the practical advantages it brings with it.

Taking into consideration the importance of science and its potential to change the society, almost all commissions and committees in our country have made efforts to make 'SCIENCE' a compulsory subject in our schools. On this line the important recommendations of different commissions and committees are mentioned here under: In India, the pattern of education was influenced by what happened in England, the only difference is that things moved at a much slower pace. The reviews issued by the Government of India in the years 1877-92 gave an insight into the sorry state of science teaching. Even in the beginning of this century science was not a school subject in our country and in universities it existed only in the name. The Report of the Secondary Education Commission (1953), recommended the teaching of General science as a compulsory subject in the high and higher secondary schools.

The All India Seminar on the teaching of science in secondary schools held at Tara Devi (Simla Hills) in 1956, dealt with almost all the problems facing the inclusion of general science as a core subject for the higher secondary classes. It had suggested a unique and uniform

system of science teaching for the entire country, suited to its needs and resources.

In view of the rapid influence of science on society and of the Government policies, it was felt that both the scientists and the politicians should be brought on a common platform to formulate new policies and procedures in accordance with the scientific development. The parliamentarians, who are the makers of the policies, must be acquainted with the developments of science and technology and with the scientific view point. As a result of this new ideology, the Indian parliamentary and scientific committee was set up in August, 1961, under the chairmanship of Late Shri Lal Bahadur Shastri. In 1963, the then USSR experts of the UNESCO Planning Mission visited India on technical assistance projects. They gave their recommendations on different issues of science education for secondary schools.

The Indian Education commission (1964-66), has pointed out that our science education is in bad shape and it becomes worse if we fail to reckon with the explosion of knowledge. The commission recommended that "We lay great emphasis on making science an important element in the school curriculum. We, therefore, recommend that Science and Mathematics should be taught on a compulsory basis to all pupils as a part of general education during

first ten years of schooling. In addition, there should be provision of special courses in these subject at the secondary stage for students of more than average ability".

As a result of this recommendation, Science has been recognized as a compulsory subject right from the Elementary stage and one of the core subjects at higher secondary stage. It will be futile to prepare separate case for the inclusion of science in the school curriculum because the reasons for its inclusion are exactly the same as those for the inclusion of subjects other than Science. However, it has been given a core place in the curriculum because of some special values provided by Science only and not by any other subject. All the school subjects are taught, because they provide liberal education, they are part of the equipment and preparation for life which one expects the school to give to its pupils so that they may play their part in the community as intellectual citizens. Science takes its place side by side with other subjects as an essential element of one's education. It affords knowledge of certain facts and laws and an insight into methods and data peculiar to the domain of science. However the inclusion of any subject in the curriculum should justify the intellectual, utilitarian vocational, cultural, moral and aesthetic values. Besides these, the teaching of

science imparts training in the 'Scientific method' and develops 'Scientific attitude' which are very valuable.

The rapid advancement of science and technology and increasing need for scientists and technologists have made it all the more important to provide for science based education in the schools. With its accelerating importance in our society science has become an increasingly important part of general knowledge.

## 1.2 VALUES OF SCIENCE

Science has now become a compulsory subject in the school curriculum because of its multifarious values to the individual as well as the society. A brief discription of some of these values have been presented in the following paragraphs.

### 1.2.1 Intellectual Values

The great value of science is that it has introduced us to new ways of thinking and reasoning. The chief part played by science in helping to develop consciousness of man is to be found in the new thoughts that it has made us think. Increase in consciousness appears to have been one of the purposes of evolution. Certainly the most significant factor in the development from 'AMOEBA' to 'MAN' seems to have been the increase in consiousness. The mere fact that science does, to a great extent,

gratify our intellectual universe we live in. And it is quite obvious that the study of science has given us a real insight of ourselves and the things around us. Science has its own discipline. It sharpens our intellect and makes us intellectually honest, critical in observation and reasoning. It teaches to arrive at conclusion without any emotional bias or prejudice.

#### 1.2.2 Utilitarian Value

The utilitarian value of science need not be emphasised. We are living in an age of science and technology. Right from the cradle to the grave, all our activities are controlled and fashioned by science. Science has entered in our life and daily activities so much that our existence would become impossible without it. Its achievements in almost all spheres are marvelous.

The achievements and the benefits of science touch all sectors and all levels of the modern society. The modern man has applied science and technology for the well being of mankind by inventing machines and by harnessing the resources of nature. The gifts of science have been profitably used for making life comfortable and raising the standard of living. But the use or abuse of the wonderful gifts of science depends on man and his mind. The recent advances in the field of science and

technology and the wide application of the achievements of science in industry, agriculture, medicine, transport, security and communication as well as their uses in domestic life justify, more than ever, the utilitarian value of science.

Taking into consideration both the aspects of science, it is, however, essential for every body to know about the achievements of science and its impact on our society, how to realize the gifts of science to achieve one's own ends to make life more comfortable and to raise the standard of living. So it is very essential to have some elementary knowledge of science of least, for becoming a useful member of the community. To raise the standard of living in any country; two things are needed scientific knowledge, and a population sufficiently educated to understand how to apply it to every day life.

### **1.2.3) Vocational Value**

Science has opened innumerable avenues for pursuing different vocations. A student of science can study engineering and technology, medicine, agriculture, or any similar subject and make one's career in that profession. In addition, scientific activities have given rise to many varieties of crafts and allied services. Science, therefore, gives opportunities for career-making, pursuing professions and vocations. In fact, if we refer

to preparation of the individual for the future as one of the aims of education, then science, as a subject, is rightly serving this purpose. It has solved the problems of leisure. The study of science at school forms the basis of many useful hobbies and other productive activities in the later life of the students.

#### 1.2.4 Cultural Value

Science has played an important role in determining the culture and civilization of a country from time to time. It has affected our way of thinking and way of living. It has a direct influence in dispelling many traditional beliefs, and the adoption of others suggested by the success of scientific method. Then as a consequence of new techniques of science the social organizations have been amply changed which are gradually bringing about corresponding political changes. What is more, the new control of science over the environment, is bringing up a new philosophy involving a changed conception of man's place in the universe.

At this juncture, it is worth noting the remark made by the Report of Indian Education Commission (1964-66), regarding the importance and integration of science with cultural and spiritual heritage." If science is to be pursued with full vigor and zest and is to become a

mighty force in the India renaissance, it must derive its 'nourishment' from our cultural and spiritual heritage and not by-pass it. Science must become an integral part of our cultural and spiritual heritage".

#### 1.2.5 Moral Value

Of the great values that condition our activities and make our lives worth living Truth, Beauty, and Goodness the man of science is mainly concerned with the disinterested passion of truth. Though comparatively, in the daily activities of mankind, that is the most unpopular of virtues yet it plays an important role in science. The reason most obviously is that science is an activity where truthfulness is the most essential condition for success, where success is not possible on any other terms. A scientific man who misrepresents his observations or deliberately makes fictitious arguments to reach a false conclusion would merely be deceiving himself as a scientific man. His generalizations by concocted arguments and false observations will not stand the test of time for long time.

#### 1.2.6 Aesthetic Value

To a layman, science is important chiefly because of its practical application and having no aesthetic charm. But on the other hand it is the most important

consideration with all scientific men for it meets one of the deepest needs of human nature which manifests itself as the desire for beauty. It is in the aesthetic aspect that the whole charm of science lies. To a man of science, practical application is just a by product of his autonomous activity. The scientist feel an intrinsic charm in revealing the harmony of nature. On the lowest level he has the satisfaction of adding to sum of human knowledge; on a higher level he enjoys the subtle pleasure of devising some hypothesis which fits a diversity of facts opening up new areas of knowledge. Application of 'fitness of purpose', the suitability of an apparatus for the job for which it was designed, can give great inward satisfaction. There is a pleasing skill in avoiding or eliminating sources of errors and in particular the errors of human observation.

Apart from the above mentioned values which are found in almost all subjects, the training in scientific method and scientific attitude are specific to science and which are transferable to other life situations.

### 1.3 IMPACT OF SCIENCE

Owing to these multifarious values of science and it being a compulsory subject in the school curriculum, science has made tremendous impact in all spheres of

human activity. A brief discription of some of those have been presented in what follows.

Science has revolutionized our life style and also brought about tremendous changes in our ways of thinking, attitudes and, outlook. Science has brought about a change in such important aspects as health, communication, transpo<sup>o</sup>rtation, power, etc. It can now be said without doubt that we owe our very existence to science.

Just as science is universal its benefits are also universal. Its material benefits are immense and have far reaching effects in the area of industry, agriculture, release of nuclear energy and so on. In addition to these science has also contributed a lot to the development of human civilization. Actually speaking modern world has been created by science an is being maintained by science. Some of the above mentioned impacts of science in different spheres of human activity have been presented here under.

### 1.3.1 Impact of science on Agriculture

Science mechanized agriculture and 'green revolution', was possible only because of such a mechanized farming. By mechanized framing and making use of tools invented by science we can now carry out various agricultural

tasks such as ploughing, sowing, reaping, harvesting and so on. The increase in yields of various agricultural products has been made possible by use of scientific techniques. For prevention of crops from insects we make use of pesticides and insecticides discovered by scientists. A spray of these insecticides at a proper time helps to increase the crop yield.

### 1.3.2 Impact of science an Health

Science has contributed a lot in the maintenance and improvement of our health, It helps us in diagnosis, treatment, and prevention of various diseases. It is only due to science that we have prevented the human society from contagious diseases and epidemics. For this we make use of various preventive techniques such as vaccination, inoculation, surgical operations. We have become health conscious because science has provided us guidance in the fields of hygiene, and sanitation, diet, physical exercise.

### 1.3.3 Impact of science on Industry

Modern industries depend to a large extent on the discoveries of science. Such discoveries have brought about drastic changes in the ways and processes of industries. The progress in science has made difficult tasks easier by use of machines. In industrially advanced

countries the different tasks are performed by machines and human beings are required only to operate machines. Science has brought about major revolutions in various industries including printing, radio and telecommunication, pharmaceuticals, agriculture, banking, armament and so on.

#### **1.3.4 Impact of Science on Modern Civilization**

Modern civilization owes its existence to science and can be easily called scientific civilization. Various advances in the fields of agriculture, medicine, cosmetics, transport, communication, etc. have affected our way of living and the modern civilization is due to the effect of such changes in our behavior. Science has helped us to overcome the age old taboos and superstitions. Science has also contributed a lot in the removal of illiteracy and ignorance. It has also brought about a change in our attitude towards religion, marriage, birth control, etc.

#### **1.3.5 Impact of Science on Democracy**

It is the change in our attitude which has been brought about by science that we have developed the qualities of a good citizen for democracy. Science help us to develop an outlook for receiving new ideas and to have a capacity for clear thinking. Science also

develops in us a real to work for the service of mankind and also to respect the views of others.

It also develops our intellectual integrity. These are the very qualities which are expected from an individual. The knowledge of science helps an individual to find useful methods for checking the bias. These ideas developed in an individual are the very basic foundations of democracy.

#### 1.4 OBJECTIVES OF TEACHING SCIENCE

The aims and objectives of education have been changing from time to time with the philosophy of life and the needs of the country. These aims of education are to be achieved in the schools through the teaching of a number of subjects. Each subject, in turn, has some general and specific objectives to be achieved. These objectives of teaching a particular subject determine its place in the curriculum in shaping the content and the method of teaching.

Objectives of teaching science as stated in various reports have been summarized as follows.

All India seminar on Teaching of Science (TARADEVI REPORT, 1956). The aims and objectives of teaching science at different stages have been summarized in the proceedings of the All India seminar of the teaching of

science held at Taradevi (H.P), published by Ministry of Education in 1956. They are as follows :

### I. Primary Level

The aims and objectives of teaching science at the primary school level should be :

- to arouse and maintain interest in nature and physical environment,
- to arouse love for nature and the habit of conserving nature and natural resources,
- to inculcate habit of observation, exploration, classification and a systematic way of thinking,
- to develop manipulative powers and creative and inventive faculties,
- to inculcate habits of healthful living.

### II. Middle School Level

At middle school level, teaching of science aims at the following in addition to the aims given above :

- to acquire a lot of information about nature and science which may also serve as the basis for a later general science course,

- to develop the ability to reach generalization and to apply them for solving everyday problems,
- to understand the impact of science upon our way of life,
- to develop interest in scientific hobbies,
- to inspire pupils by telling them stories of some great scientists and their discoveries.

### III. High and Higher Secondary Level

At this stage, the aims of teaching science are :

- to familiarize the pupil with his surroundings and to make him understand the impact of science on society and thus enable him to adjust himself with his environment,
- to familiarize him with 'scientific' attitude,
- to make him understand the evolution of science in the historical prospective.

The Indian Education Commission (1964-66), has suggested the following aims and objectives of teaching of science at various levels.

#### I. Lower Primary level

- At the lower primary stage the accent should be on

the child's environment- social, physical and biological.

- In classes I and II, the accent should be on cleanliness and formation of healthy habits.
- Development of power of observation.
- In classes III and IV, the study should also include personal hygiene and sanitation.
- In class IV, children should be taught the Roman alphabets. This is essential as the internationally accepted symbols for the units of scientific measurement and the symbols of chemical elements and compounds are written in the Roman alphabet.
- Developing proper understanding of the main facts concepts, principles and processes in the physical and biological environment.

## II. Higher Primary level

The teaching of science at this stage should emphasize on the acquisition of knowledge alongwith the ability of logical thinking and drawing conclusions for taking decisions at a higher level. At this stage a disciplinary approach of teaching science is favoured instead of an integrated science teaching. The teaching

of physics, chemistry, botany, etc., is likely to develop more effective scientific base.

### III. Secondary level

- At this stage science should be taught as a discipline of mind and a preparation of higher education.
- In lower secondary classes (classes IX and X) the subjects of physics, chemistry, biology and earth sciences be made compulsory.
- At higher secondary stage diversification of courses and provision for specialisation be allowed.

Ishwarbhai Patel Committee (1977), remarked that the present education system is urban-oriented, bookish in outlook and almost entirely divorced from manual activity. In terms of opportunity this has proved discriminatory against the poor and weaker sections of society. The committee, therefore, feel that the principles of Basic Education as evolved by Mahatma Gandhi and accepted in the Kothari Commission Report with the stress on work education need to find a central place in the educational system.

The committee suggested that education during the ten

years of schooling should be provided to achieve the following objectives,

- to promote an understanding and appreciation of our cultural heritage while simultaneously stimulating desirable changes in our traditional culture pattern,
- to mould the learner after the image of the citizen as visualised in the constitution,
- to release learning from its bookishness and elitist character so as to relate of closely to socially productive manual work and the socio-economic situation of the country,
- to encourage rationalism and the scientific attitude.
- to emphasis the qualities of simplicity, integrity, tolerance and cooperation in all aspects of life,
- to be available to every individual irrespective of caste, creed, sex, age, place of birth, or economic circumstances and in such a way that working and learning can always be combined.

According to NCERT (1990), the objectives of teaching Science at the upper primary stage are to :

- consolidate and strengthen the abilities acquired at the lower primary stage,
- help the pupils understand and appreciate the nature of scientific knowledge that :
  - (i) It is replicable
  - (ii) It is based on observation.
  - (iii) It is tentative
  - (iv) It is empirical
  - (v) It is holistic,
- emphasise the relevance of scientific knowledge and of the method of science in daily life,
- create an environment conducive to greater reliance on the use of principles and practices of science,
- acquaint the pupils with the different natural phenomena,
- develop an understanding of scientific language (Symbols and formulae) knowledge and skills for designing simple experiments,
- emphasise those principles, concepts, laws and theories of science that are relevant for interacting with the environment,
- emphasise the unity of processes in the different disciplines of science,

- develop the scientific attitude, such as open mindedness, intellectual honesty, the courage to question and respect for human dignity,
- emphasise the steps involved in proper decision making based on the scientific method,
- use science as a means of developing proper social and moral values in the pupils.

The objectives of teaching Science at the secondary level are to :

- consolidate and strengthen the abilities acquired at the upper primary stage,
- acquire an understanding of scientific concepts principles and laws,
- develop instrumental, communicational and problem solving skills,
- develop the scientific temper and the scientific attitude, such as open mindedness, intellectual honesty, the courage to question, and respect for human dignity,
- cultivate, social, ethical, moral, and aesthetic values which exalt and refine the life of the individual and the society,

- appreciate the contributions of scientists and develop sensitivity to possible uses of science, and concern for a clean environment and the preservation of the ecosystem.

The objectives of teaching science have undergone an immense change ever since it has formed as one of the core subjects. Sharma (1990), notes that "a remarkable change was observed in objectives of teaching science after world war II. More emphasis was placed on developing scientific concepts, principles, skills in laboratory work and problem-solving, attitudes, appreciations and interests."

The unexpected developments in the field of science and technology in twentieth century have made position for it self in the school curriculum but have affected the ultimate objectives of education also. If one looks back at the objectives of teaching science in the early twentieth century one finds that major stress was on the teaching of facts of science. It may be dangerous if only acquisition of scientific knowledge is emphasised without giving importance to process aspect of science. A similar remark has been made by Acharya Rammurti's committee (December 1990), "The objectives of science teaching it self should be inculcation of scientific temper. Emphasis should not be on mere acquisition of

scientific knowledge but use of scientific method as a tool of acquiring knowledge. 'How is as important as 'why'".

From the comparative study of the objectives of teaching science after independence in our country, it becomes clear that there is not much change in the focus of objectives of teaching science. Indeed, there has been minor change in the focus of objectives of teaching science with time. For example, Ishwarbhai Patel committee (1977), emphasised more on the line of Basic education philosophy evolved by Mahatma Gandhi and hence the stress was more on socially useful productive work. Still, the common focus of objectives of teaching science by all the four reports referred can be summarised as follows :

Science should be taught to the children so that they understand their natural, physical and social environment by acquiring knowledge about it and try to understand the usefulness and application of the acquired knowledge to daily life activities. They understand impact of science on society. They acquire power of observation, critical and logical thinking. They develop habit of maintaining clean environment and its conservation. They acquire skills of experimentation. Science should also be taught for the cultivation of values like social, moral,

cultural, aesthetic and qualities like simplicity, tolerance and cooperation helpful for becoming better citizen of the country. They should also develop interest in scientific hobbies so as to utilise their leisure time productively. They should learn to appreciate the contribution of scientists.

The development of scientific attitude as highlighted by the aforementioned objectives of teaching science, has also been endorsed by NPE (1986), in the following way: "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."

The development of scientific attitude and of scientific method is not limited to contacts with natural environments. All avenues of learning, all subjects of study, all experiences and activities lend themselves to the practice of it. It is, however, through 'SCIENCE' that scientific attitude and scientific method is most accurately developed. Data can be more easily and extensively gathered, readily manipulated, controlled, and properly checked than in other area of school curriculum.

### 1.5 SCIENTIFIC ATTITUDE

One of the major aims of teaching science is the development of 'scientific attitude' in the students. The scientific attitude is made up of a cluster of behaviours to be manifested by the individual. Though the development of 'scientific attitude' in the pupils has been emphasised by almost every commission and committee, it is surprising to note that there is not a single definition of it i.e. it has not been defined clearly and precisely. Researchers and authors have defined it differently in their own way to serve their purpose. Following are some of the definitions of 'scientific attitude'.

To John Dewey, a scientific attitude was linked with "an ardent curiosity, fertile imagination, and love of experimental inquiry". He pointed out that "Young people who have been trained in all subjects to look for social bearings will also be educated to see the causes of the present problems and phenomena. They will be equipped from the sheer force of what they have learned to see the possibility and the needs of actualizing then they will be indoctrinated in its deeper sense without having doctrines forced upon them.

National Society of the Study of Education (NSSE) has defined scientific attitudes as "open-mindedness, a

desire for accurate knowledge and the expectation that the solution of the problem will come through the use of verified knowledge." The views regarding scientific attitude expressed at a work shop conducted by the National Council of Educational Research and Training (NCERT) at Chandigarh (1971), can be summarised as follows :

A pupil who has developed scientific attitude,

- is clear and precise in his activities and makes clear and precise statements,
- always bases his judgment on verified facts and not on opinions,
- prefers to suspend his judgment if sufficient data are not available,
- is objective in his approach and behaviour,
- is free from superstitions,
- is honest and truthful in recording and collecting scientific data,
- after finishing his work takes care to arrange the apparatus, equipments, etc. in their proper places,
- shows a favourable reaction towards efforts of using science for human welfare.

The scientific attitude, by its very name, tends to be associated solely with the area of science and scientific methods. Actually, the scientific attitude is applicable to nearly every situation an individual may encounter in mathematics, social studies, science, and other subjects in the curriculum. It is closely allied to critical thinking, and it is developed through the study of language as well as other subject matter areas.

The scientific attitude can be a valuable result of the problem-solving approach to learning. It is encouraged when study is attacked through.

- (1) identifying a problem,
- (2) making valid observations.
- (3) drawing objective conclusions,
- (3) verifying the conclusions to a new but related problems.

These steps are those ordinarily associated with scientific methods of investigation and closely allied to the steps involved in the problem-solving method.

The solving of problems in an orderly manner leads to the development of an objective attitude that is applicable to many situations. It can be developed in

many subjects in the curriculum and applied in adult life as well as in school life.

Sharma (1990), views scientific attitude as "Scientific attitudes are the most important outcomes of science teaching. Though some people view the scientific attitudes as the by products of teaching science yet a majority of the people consider them as equally important as the knowledge aim. Science should be taught directly and systematically because developing scientific attitude has a number of characteristic features which distinguish it from other attitudes". He further describes a man with scientific attitude,

- is critical in observation and thought,
- is openminded,
- respects other's points of view and is ready to change his decision on presentation of new and convincing evidence,
- is curious to know more about the things around him, wants to know 'why', 'what' and 'How' of the things he observes,
- is objective in his approach to problems,
- does not believe in superstitions and false beliefs,

- suspends judgments until suitable, support is obtained,
- believes in cause and effect relationship,
- is truthful in his observations and draws conclusions based on accurate facts,
- is unbiased and impartial in his judgments,
- adopts a planned procedure in solving a problem,
- believes that truth never changes, but his ideas of what is true may change as he gains better understanding of that truth,
- accepts no conclusion as final or ultimate,
- seeks to adopt various techniques and procedures to solve the problem,
- selects the most recent, authoritative and accurate evidence related to the problem,
- seeks the facts and avoids exaggeration.

Srivastava (1980), has defined scientific attitude as rationality, curiosity, open-mindedness, aversion to superstition, objectivity, intellectual honesty, and suspended judgment.

Vardhini (1983), has defined scientific attitude as: empiricism, curiosity, freedom from bias, openmindedness, criticality, intellectual honesty, seeks evidence, and observation.

Most authors in the literature referred, find scientific attitude to be an attribute made of certain behaviours. In our country, srivastava (1980), Sindhe (1982), Vardhini (1983), and Ghosh (1986), have developed instruments to measure scientific attitude of students. Referring to their work and other available literature with regard to scientific attitude, it is 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. On the basis of above stated facts and after a thorough investigation of the available literature on scientific attitude, the investigator has arrived at the following ten components of scientific attitude. They are as follows.

1. RATIONALITY
2. CURIOSITY
3. OBJECTIVITY
4. OPENMINDEDNESS
5. CRITICALMINDEDNESS
6. INTELLECTUAL HONESTY
7. OBSERVATION.
8. HUMILITY
9. ENVIRONMENTAL AWARENESS
10. COURAGE TO QUESTION.

Under each of these components, the behaviours which may be used to describe the particular component are listed as follows.

**1. RATIONALITY :**

- The search for plausible solution 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 and effect relationship
- Aversion to superstition.

**2. CURIOSITY**

- Tendency to know more about events, objects, and phenomena which can not be explained by the existing knowledge.
- Reading to get information.
- 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 judgment needed in collecting in 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 statements.
- Questions the 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 of 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.

In the list of the set of behaviours stated under each component of scientific attitude one may perceive an overlapping in respect of some behaviours. This may be observed due to the fact that 'Scientific attitude' is the result of several behaviours and therefore, it may not be possible to categories with strict certainty the behaviours under various components so as to make them totally exclusive of each other.

In this chapter the discussion on the importance of science through its multifarious values and its impact on modern civilization has led in preparing a ground for the acceptance of science as a compulsory subject in the school curriculum. Further, the objectives of teaching science have been discussed with a view to arriving at the emphasis on the inculcation of scientific attitude. The examination of the available literature on scientific attitude has helped the researcher in arriving at the identification of components and the behavioural specification of each identified components of scientific attitude. In the chapter to follow, a detailed discussion on the studies available in the area of scientific attitude have been done with a view to drawing the implications for the present piece of research.