CHAPTER – I

INTRODUCTION

1.1 WHAT IS SCIENCE?

Man was always curious to know about the things around him. The curiosity of man to know about nature and to unveil its mysteries led to the establishment of certain knowledge based upon facts. Genius persons, by their persistent efforts, careful experimentation and exact reasoning have collected a mass of information. Science is concerned with what is? Different scientists give different definitions of science.

According to Frederick (1960) “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”.

In the ‘The Columbia Encyclopedia’ (1963) science is defined as “an accumulated and systematized learning, in general usage restricted to natural phenomenon. The progress of science is marked not only by an accumulation of facts, but by the emergence of scientific method and of the scientific attitude”.

According to Vasistha and Gill (1987) the word Science is derived from the Latin word ‘Scientia’ which means knowledge. Thus knowledge is acquired by the scientific method or the procedure of science. Science may be defined as knowledge, which is generally accepted because it has been proved to be true and which has been classified and arranged so as to demonstrate general truths or the operation of natural laws.

From these 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
3. The scientific attitudes
The first point indicates the PRODUCT of science, while second and third points indicate the PROCESS of science. In other words, science is both a product and process.

Henri Poincare explains the idea this way: “Science is built of facts as a house is built of stones; but an accumulation of facts is no more a science than a heap of stones”. The true nature of science is revealed more in the way it is sought rather than in what is found, although the two efforts cannot be truly separated. In another way, it could be said that science is more a verb than it is a noun: Science is the cyclic enterprise consisting of the formulations of model of explanation from facts which in turn predict the occurrence of unsuspected facts. If these new facts are indeed found, the value of the model is increased. If the facts are not found, the model is changed and new model is suggested to predict new facts and so on. The following diagram gives an idea of the relationship between facts and the formulation of model or theory.
Science is also defined as “Science is what scientists do”. In order to understand this definition of science we have to understand how scientists work. There are at least three basic things that the scientists do. These are:

1. Scientists make descriptions – Scientists always search for the answer to questions such as what is the universe? How many? How much? How long? How frequently? Where? When? Under what circumstance? etc. by using ‘Scientific method’. The descriptions made by one scientist on the basis of his observations and critical thinking are open to verification and change by other scientists.
2. Scientists make explanations – The scientists after having described an event or phenomenon, attempt to find out the ‘reason’ or ‘why’ such event and phenomenon occur the way they do. And explanation is a very careful description which involves knowledge of the different factors or variables.

3. Scientists make predictions – Extending our knowledge to new situations involves prediction. Making use of a concept of generalizations or law in a situation which has not yet been tested involves predictions. Thus the scientists use ideas of their known and of others as tools for testing and gaining knowledge. They use many resources to get valid answers to their questions and problems. They design their own experiments and invent new tools with which they observe and check different phenomena. In other words science can be defined as “the process by which we increase and refine understanding of ourselves and of the universe through continuous observations, experimentation, application and verification.
The major items in the process of science as advocated by the National Science Teachers Association, Washington in 1964 are as follows:

1. Science proceeds on the assumption, based on centuries of experience, that the universe is not capricious.

2. Scientific knowledge is based on observation of samples of matter that are accessible to public investigation in contrast to purely private inspection.

3. Science is not, and probably never will be a finished enterprise, and there remains very much more to be discovered about how things in the universe behave and how they are interrelated.

4. Science proceeds in a piecemeal manner, even though it also aims at achieving a systematic and comprehensive understanding of various sectors or aspects of nature.

5. Measurement is an important feature of most branches of modern science because the formations as well as the establishment of laws are facilitated through the development of quantitative distinctions.
6. Scientific facts are tentative – the facts, models or theories which are proved wrong in the course of time are discarded and replaced by new ones. The whole process of the scientific enterprise is continuously replenished by new facts and discoveries.

7. Scientific facts are open to various interpretations. The scientific facts and principles are never absolutely true. They may be true from one point of view but may be false from another depending on the frame of reference. The same object or phenomenon can be looked and interpreted in different ways.

So we can conclude that science prefers problems where variables can be rigidly controlled, science is able to win wide and almost universal support for its conclusions and in reaching the prized advantage of reliability and objectivity. Science sacrifices the breadth of scope of its conclusions and gives a more refined explanation.
1.2 DEVELOPMENT OF SCIENCE EDUCATION IN INDIA BEFORE INDEPENDENCE.

India made a pioneer headway in the field of mathematics, medicine, astronomy, agriculture and architecture till about 600 A.D. Rig – Veda refers to physicians and speaks of the healing power of medicinal herbs. The concept of atom and the formation of the world as discussed in ‘The Vais’eshika’ one of the Upanishads, approaches the modern western thought. The Sankhya philosophy by Kapila is very much like Darwinism. The Upa-Vedas discuss various sciences. One of this ‘Upa – Vedas’ is ‘Ayur – Vedas which consists of six books on surgery, nosology, anatomy, therapeutics, toxicology and supplementary section dealing with various local diseases. Great attention was given to diet. In surgery they attained great proficiency. The material medica of the Hindus embraced a vast collection of drugs belonging to the mineral, vegetable and animal kingdom many of which have been adopted by western physicians. There were colleges and universities of international repute.

There was considerable development and refinement of observation, from the point of view of methods and techniques of acquiring scientific knowledge. Institutions were centered around individual, who passed on the knowledge
and skill to their best disciples only. Taxila and Nalanda Universities could be taken as a first step towards institutionalization of teaching and acquiring knowledge but these universities gradually disappeared. The philosophy of Buddhism (between 750 A.D. to 1000 A.D.) discouraged further development of life sciences. Due to strict caste system Brahmins forbade to contaminate with blood and withdrew from all practice of medicine. In the medieval period the foreigners brought the scientific ideas to India. The large number of scholars went out of India to the West Asia and Central Asia.

There was sharp break in the scientific thought and tradition of India with the conquest of the country by the British Modern Science was introduced along with the British in the foreign language i.e. English. But in this period the science was not developed.

At the end of the 18th century there was no place of science in the school curriculum. Chief scientific discoveries were made by some amateurs and some philosophical societies to fill the gap between the educational provision and social needs. A full survey of the position of science teaching in secondary schools is contained in the
Devonshire Commission Report published in 1895. This report recommended that:

i. In all schools a substantial portion of the time allotted to study be devoted to Natural Science, and that not less than six hours a week on the average should be assigned for this purpose.

ii. School laboratories should be constructed to supply accommodation for practical work in Physics as well as in Chemistry. This report marked the beginning of introduction of Physics and Chemistry in the curriculum at Boy’s schools and of Botany into the Girl’s schools.

Society of Arts of London published a book entitled, “How to learn and what to learn” for the guidance of candidates and started the science examination in 1852.

H.E. Armstrong, Professor of Chemistry in The Central Technical College, City of Guides of London institute discovered a new teaching method known as Heuristic method (pupil centered method).
The great World War of 1914 – 18 increases the importance of science in the world. ‘Thomson Report’ was published by Sir J.J. Thomson under the title ‘Natural Science in Education’. After this report science was added to many schools. The Science Master’s Association and the Association of Women Science Teacher were formed. School Science Review, the S.M.A. Periodical created a good influence on the teacher as well as the public. In ‘Spens Report’ which was published in 1938 by Sir Will Spens. It was said that teachers were, however, disappointed with the attitude of the Report towards school science. Under the consequences of all the reports an Education Act 1944 came into force in April, 1945 which has meant an increase in the amount of science taught through not to the extent to which it should have been.

1.3 Development of Science Education After Independence

The pattern of education in India was influenced by what happened in England. At the beginning of this century science was not a school subject and it was only in universities. After independence some seminars were held and some commissions were set up. They gave recommendations about the education policy.
All India Seminar on the Teaching of Science in Secondary School held at Tara Devi (Simla Hills) in 1956, dealt with almost all the problems facing the inclusion of the 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 need and resources.

Indian Parliamentary and Scientific Committee was set up in August, 1961, under the Chairmanship of Late. Shri Lal Bahadur Shastri. This committee studied the problems of “Science Education in Schools”. They also studied the allied problems of:

1. Growth of school population.
2. Shortage of qualified teachers.
3. Accelerated achievements in science.
4. The demand for increase in technically trained manpower.
5. Growing importance of science in the affairs of mankind.
6. Changes in the processes and goals of science.
7. The views held by different thinkers in regard to the structure of the school system and the content necessary for education of youth.
In 1963, the USSR Experts of the UNESCO Planning Mission visited India on technical assistance projects. They worked on the problems from 23rd December 1963 to 10th March, 1964 and gave their recommendations on different issues of science education in Secondary Schools. Three reports were prepared by the team. These reports gave the total picture of the position of Science and Mathematics education in India and suggested ways to improve it. As a follow-up programme of the Report of UNESCO Planning Mission of Experts, the Department of Science Education in the National Council took up the pilot project of preparing new curriculum, text books, teachers guide etc. To start with, these experimental projects were started in about 20 selected schools in Delhi. From 21st-23rd April, 1966, a conference of Science Education was convened under the Chairmanship of Dr. Kothari to plan an effective programme for the development of a total curriculum of science education for different stages. Indian, Russian, American, and UNESCO experts in science education participated in the conference.

Indian Education Commission (1964-66) was set up under the Chairmanship of Dr. D.S. Kothari. The commission has pointed that our science education is in bad
shape and it becomes worse if we fail to reckon with the explosion of knowledge. To meet this immediate threat, the commission recommended upgrading the school curriculum by research in curriculum development, the revision of text books and teaching learning material. The commission recommended that:

1. Science and mathematics should be taught on a compulsory basis to all pupils as a part of general education during the first ten years of schooling.

2. In the lower primary classes science teaching should be related to the child's environment. The Roman alphabets should be taught in class IV to facilitate understanding of internationally accepted symbols of scientific measurement and use of maps, charts and statistical tests.

3. At the higher primary stage emphasis should be on the acquisition of knowledge and the ability to think logically to draw conclusions and to make decisions at the higher level. A disciplinary approach to the teaching of science will be more effective than the general science approach.
4. A science corner in lower primary schools and a laboratory – cum – lecture room in higher primary schools are minimum essential requirements.

5. At the lower secondary stage, science should be developed as discipline of the mind. The newer concepts of physics, chemistry and biology and the experimental approach to the learning of science should be stressed.

6. Science courses at an advanced level may be provided for talented students in selected lower secondary schools with necessary facilities of staff and laboratory.

7. Science teaching should be linked to agriculture in rural areas and to technology in urban areas.

8. The method of teaching science should be modernized, stressing the investigatory approach and the understanding of the basic principles. Guide materials should be made available to help the teachers to adopt this approach. Laboratory work will need improvement. There should be flexibility in the curriculum in order to cater to the special needs of the gifted.
9. The development of science must derive its nourishment from our cultural and spiritual heritage and not by pass it.

10. At the university level better conditions for research should be provided.

The NCERT was established on September 1, 1961 as an autonomous organization with its headquarters in New Delhi. At the headquarters it has the National Institute of Education (NIE) which is concerned with research, instruction and evaluation. The NIE functions through various departments, units of library, National Science Talent Search, work experience/vocationalization, survey and Data processing and Examination Reform.

In addition to the NIE, the Council runs four Regional Colleges of Education at Ajmer, Bhopal, Bhubaneshwar and Mysore. The Regional Colleges are meant to function as centers of excellence in the field of teacher education. All the departments of NIE and the Regional Colleges of Education and NCERT function as the academic wing of the Ministry of Education and Youth Services of the Government of India. It also maintains a close relation with the
education departments and the schools in different states and the Union territories of India.

State Institutes of Science Education have been set up in all states. The main functions of these institutes are to provide in-service training to science teachers, prepare instructional material in science, conduct research studies in science education and take up innovative programmes in science education.

1.4 ATTITUDES

Attitudes are important keys in understanding the long range organization of behaviour. The prominent role of attitudes in determining our thought, memory and learning processes has been recognized by various psychologists. Good (1973) said that, attitude is "readiness to react towards or against some situation, person or thing or resentment to a particular degree of intensity".

Attitude is a specific mental state of the individual towards something according to which his behaviour towards it is moulded. Allport (1935) has defined an attitude as a "mental and neural state of readiness organized through
experience, exerting a directive or dynamic influence upon the individual’s response to all objects with which it is related”.

This definition reveals the following facts concerning attitudes:

a) Attitude is the mental or neural state of readiness.
b) Attitude influences the reactions of the individual.
c) Attitude changes the reactions of the individual.

Young (1951) has defined attitude as a learned and more or less generalized and affective tendency or predisposition to response in a rather persistent and characteristic manner, usually positively or negatively (for or against) in reference to some situation, idea, value, material object or class of such objects or person or group of persons. This definition of attitude improves the definition by Allport in this respect that it introduces the following two elements:

a) Attitude is generally negative or positive.
b) Attitude is a learned or acquired affective tendency.

Attitudes result from personal desires and group stimulation. They actually are a part of individual’s own personality. According to Crow and Crow (1991), “Attitudes are personal and relate to feelings of a person”. Attitudes are
uniquely organized in each person. As Sherif and Cantril (1947) had put it, “Most attitudes have the characteristic of being part of me”. Attitudes can be copied from others and they need not be on the basis of personal experiences. For example a child often accepts the attitudes of his family towards various things. Children are great imitators of attitudes.

An attitude is a complex affair which cannot be wholly described by any single definition. Thurstone and Chave (1929) believes that “attitude is complex of man’s inclinations, feelings, bias, ideas, fears, threats, etc. Opinion is verbal expression of attitude. Some attitudes are so deeply ingrained as to appear permanent, while others are nearly transitory and may change overnight”. Katz, Stotland, Kelman (1961), Sornoff and McClintok (1956) are the adherents of the functional approach which maintains that attitudes change and develop as they serve to promote or support the goal of the individual. Attitudes supply principles on the basis of which choices are made. They are the threads which run through and colour all human experiences.

Like other aspects of personality, attitudes are acquired and not innate. No one is born with an attitude; they are learned in a culture in course of individual’s
development. Sherif and Cantril (1947) defines attitude as “A habitual way of looking at an object, a person or an idea. Attitudes are learned often unconsciously and are always tinged with emotion of fear, love or hate. Some of our attitudes come from straight thinking, from direct experience, but the majority is born of prejudice and merely reflects the attitude of our parents, teachers and friends”. So individual attitudes are developing moment by moment.

Attitudes operate in specific behaviour pattern and are associated closely with emotional reactions. According to Woodworth, an attitude is “a set or disposition (readiness, inclination, and tendency) to act towards an object according to its characteristics so far as we are acquainted with them”. He suggests that when an attitude is inactive it may be called a disposition and when an attitude consists of strong feeling it may be called a sentiment. Dutt (1974) had also pointed out that attitudes are not purely cognitive in nature but cognitoe motive in nature, i.e., they have two components, viz., cognitive and emotional towards psychological objects – complex or simple. Attitudes are about generalized objects. Katz (1960) emphasized “Attitude is the predisposition of the individual to evaluate some symbol, or object or aspect of his world in a favourable or unfavourable manner… Attitudes
include the affective, or feeling core of the liking or disliking, and the cognitive or belief, elements which describe the effect of attitude, its characteristics, and its relations to other objects”.

According to Gates (1963), “An attitude is primarily an inner state rather than an overt experience”. Kelman (1961) views attitude change at three levels, viz. compliance, identification and internalization. Asch (1952), Sherif and Sherif (1956) and others maintain that attitudes are primarily due to reinterpretation or redefinition of the objects of the given attitude.

Krech and Crutchfield (1948) defined an attitude as, “an enduring organization of motivational, emotional, perceptual and cognitive process with respect to some aspect of the individual’s world”.

Ferguson (1952) tries to differentiate the concept ‘interest’, from the term ‘attitude’. According to him, the concept interest covers such things as are likes and dislikes, our preferences and aversion. In contrast the concept ‘attitude’ covers our beliefs. We believe that something is right or that something is wrong. We favour the object in preference to that. We accept this position and reject that position. This believing
and disbelieving, this favouring or not favouring, this accepting or rejecting constitutes the expression of attitude. To illustrate.... "Our interest in bananas and our attitude towards bananas are two independent concepts, we can believe that bananas are good for children (attitude) but still not like them (interest)....an interest is an expression of feeling, whereas the attitude is an expression of belief".

Kuppuswamy (1993) have made analysis of attitudes and reveals that they have four dimensions – direction, intensity, extension and duration. The direction of an attitude is either positive or negative, i.e. for or against some object or value. This is the aspect of the attitude which is usually measured. The intensity of a positive or negative is the degree to which it motivates the person’s behaviour towards the activity component. People who are strongly in favour or strongly opposed to a certain object naturally have more intensity than those closer to the center of the continuum. The extension of an attitude is the degree to which it is generalized or the number of cases it covers. The duration of an attitude is a length of time it endures.

Attitudes can exert a potent influence on an individual. They act as cause as well as results of behaviour.
They represent the way one feels or thinks, acts or talks in a situation.

In simple words we can sum up:

a) Attitudes underlie many of the significant at dramatic instances of man’s behaviour.

b) Attitudes, when fully developed function as internal frame of reference.

c) Attitudes work as state of readiness for motive arousal.

d) Attitudes serve as fabric for the philosophy of the life.

e) Attitudes give continuity to human personality. Human existence is not conceivable without them.

f) Attitudes give meaning to one’s daily perception and activities.

Ausekar (1995) points out that positive attitude promote growth; negative attitudes hinder growth; critical attitude help in taking wise decisions and tolerant attitudes help in adjusting to new situations. Positive attitude are essential if one wants to gain from study of science. Negative attitudes are more influential than positive ones.

So we can say that attitudes provide us with a personal outlook on the world through our feelings,
biases, preconceived notions, ideas, fears, threats and convictions.

1.5 **SCIENTIFIC ATTITUDE**

Science teachers all over the world have long recognized that development of proper scientific attitude is an important outcome of science teaching. A vitalized study of science with emphasis on open-mindedness, tolerance and objectivity will lead to the development of rational outlook and scientific attitude.

Ausekar (1995) had defined scientific attitude as “Open-mindedness, a desire for accurate knowledge, confidence in procedures for seeking knowledge as the expectation that the solution of the problem will come through the use of verified knowledge”. This is the Operational definition of the term scientific attitude. According to Vaidya (1971), “Scientific attitude has been defined as set of emotionally toned ideas about science and scientific methods and related directly or indirectly to a course of action”.

According to another view, scientific attitude include freedom from bias, prejudice and superstitions,
open-mindedness, critical mindedness, intellectual honesty, beliefs when new evidence is available. Scientific attitudes are certain mind – sets in a particular direction. So by adopting varied techniques, such mind sets in a particular direction can be developed.

Comte (1968) had defined scientific attitude as “The highest level of intellectual insight”.

Srivastva (1980) had given the following major components of scientific attitude:-

1. **Rationality**
   a) Commitment of the value of rationality.
   b) Tendency to test traditional beliefs.
   c) Seeking of natural course of events and identification of cause and effect relationship.
   d) Acceptance of criticalness.
   e) Challenge of authority.

2. **Curiosity**
   a) Desire for understanding new situations that are not explained.
   b) Find out the ‘whys’ and ‘hows’ of observed phenomenon.
c) Give emphasis on the questioning approach of novel situations.
d) Desire for completeness of knowledge.

3. Open-mindedness
   a) Willingness to revise opinions and conclusions.
   b) Desire for new things and ideas.
   c) Rejection of singular and original approach to people, things and ideas.

4. Aversion to Superstitions
   a) Rejection of superstitious beliefs.
   b) Acceptance of scientific facts and explanations.

5. Objectivity – Intellectual Honesty
   a) Demonstration of the greater possible concern for observing and recognizing facts without any influence of personal pride, bias or ambition.
   b) In interpreting results, does not allow any modifications according to present social, economic or political situations.
6. Suspended Judgements
   a) Unwillingness to draw inference before evidence is collected.
   b) Unwillingness to accept facts, things that are not supported by convincing proof.
   c) Avoidance of quick judgement and jumps to conclusion.

7. Cause and Effect Relationship
   The person with scientific temper looks for the natural cause for things that happen i.e. he
   - Does not believe in superstitions, such as charms or good or bad luck.
   - Believes that there is no connection, necessarily between two events just because they happen at the same time, one after the other.

8. Evaluation:
   A person with scientific attitude evaluates techniques and procedures used and information obtained, i.e. he –
   - Uses planned procedures in solving his problems.
   - Seeks to use the various techniques and procedures which have proved valuable in obtaining evidence.
- Seeks to adopt the various techniques and procedures to the problem at hand.
- Personally considers the evidence and decides whether it relates to the problem.
- Infers whether the evidence is sound, sensible and complete enough to allow a conclusion to be drawn.
- Selects the most recent, authoritative and accurate evidence related to the problems.

9. **Seeks Evidence**

His opinions and conclusions are based on adequate evidence i.e. he –

- Is slow to accept as facts anything not supported by convincing proof.
- Bases his conclusions upon evidence obtained from a variety of dependable sources.
- Searches for the most satisfactory explanation of observed phenomenon.
- Sticks to the facts and avoids exaggeration.
- Does not allow his personal pride, bias, prejudice or ambition to change the truth.
- Does not jump to conclusions.
10. **Scepticism:**

   Scientific attitude includes Scepticism i.e. not taking things granted.

11. **Faith in the possibility of solving problems:**

   A person with scientific temper would tend to look at the problems as things that we can solve a little bit at a time. Whereas most people believe that there are problems that human intelligence will never solve like war, poverty, ignorance, sickness and all sorts of misery.

12. **Desire for Experimental Verification**

   The average man, having once decided that something is true, has no desire to carry the matter further. But person with scientific attitude always desire for experimental proof.

13. **Loyalty to truth:**

   A scientist is sometimes subjected to humiliations as his findings shift and invalidate some conclusions to which he has committed himself but his loyalty to truth would never suppress the new data.
14. **An objective attitude:**

   A person with scientific attitude has a high regard for facts and tries to behave in accordance with them, while an unscientific person tends to see only the facts he wishes to see and to react emotionally against others.

15. **Desire for completeness of knowledge:**

   A scientist is often impelled to round out his knowledge of a subject; to fit every piece into its place like jig-saw puzzle.

16. **Keen observations**

   Scientific attitude means a determination to be careful and accurate in all one’s observation.

17. **Critical mindedness**

   A man with scientific attitude is critical in observation and thought including self-criticism.

18. **Impartial**

   The person is unbiased and impartial in his judgement.
19. **Faith in Scientific Method**

A person with scientific attitude adopts a planned procedure in solving a problem i.e. scientific method.

20. **Accuracy**

The person would have readiness to calculate accurately, use words correctly, read carefully, and is accurate in statements.

**Some more definitions of Scientific Attitude:**

Wolfe (1923) stresses the fact that “it must be firmly borne in upon us that scientific attitude rests upon one and only one fundamental article of faith, faith in the university of cause and effect. Without this faith, a steady, undaunted pursuit of scientific knowledge as a guide to action may be incontinently flouted whenever it interferes with special interest or prejudices”.

To Francis (1924) “scientific attitude meant an inherent stimulus to climb the path that leads to knowledge with the strength to reach the summit – one which, if hindered and thwarted, will fret and strive until all hindrance
is overcome, and it is again free to follow its labour-loving instinct”.

For John Dewey (1933) a scientific attitude was linked with “an ordent curiosity, fertile imagination and tone of experimental inquiry”.

According to Victor “Scientific attitude includes the habits like accuracy in all operations, intellectual honesty, open-mindedness, suspended judgement, looking for true cause and effect relationship, criticalness including self criticism”.

According to Diedrich (1967) scientific attitude includes, “a desire for experimental verification” as a component labeled “Scepticism” as “unwillingness to accept the statements which are not supported by evidence defined as verification of prediction”.

Kurz (1976) “a belief is true if and only if, it has been confirmed, directly or indirectly, by reference to observable evidence”.

Nair (1971) said that “scientific attitude is characterized by intellectual honesty, objectivity in drawing
conclusions, adoption of scientific and systematic procedure, open-mindedness in receiving new ideas and facts, curiosity, readiness to reconsider one’s own judgements, spirit of teamwork, self-help and self-reliance, intellectual satisfaction from scientific pursuits, economy in use of materials, honest recording and reporting of observation, faith in cause and effect relationship, pursuing activities with consistency, preparedness to face hardships and difficulties, a sense of dedication and faith in specialists in their respective fields”.

According to Kohli (1986), “the person possessing scientific attitude looks for natural causes for the thing that happens, curious concerning the things he observes, open-minded towards work and other’s opinion, evaluates techniques and procedures and make the opinions and conclusions based on adequate evidences”.

Vaidya (1999) explained that “scientific attitudes are open-mindedness, curiosity, judgement based upon scientific facts alone, willingness to test and verify conclusions, faith in cause and effect relationship, honest reporting, rejection of the principle of authority and more faith in the books written by specialists in their respective fields etc.”
The students should be made aware about the facts and they should develop the tendency of verifying the facts in a scientific manner.

Qualities of a person who possess scientific attitude as given by Kohli (1986) are written as under:

1. The person having scientific attitude does not believe in superstition, such as charms or good or bad luck.

2. He is curious concerning the things he observes.

3. He is open-minded towards work and opinions of others and information related to his problem.

4. He evaluates techniques and procedure used and information obtained.

5. His opinion and conclusions are based on adequate evidence.

Good (1973) had defined scientific attitude “as a set of emotionally toned ideas about science”.
and scientific methods and related directly or indirectly to a course of action. In the literature of science education, the term implies such qualities of mind as intellectual curiosity, passion for truth, respect for evidence and an appreciation of the necessity for free communication in science.

NCERT conducted a workshop at Chandigarh in 1971 and evolved the following scientific behaviour of a pupil who have developed scientific attitude. The pupil:

- is clear and precise in his statements and activities.
- bases his judgement on verified facts (not on opinion).
- is willing to consider new ideas and discoveries (free from prejudices).
- reacts favourably to efforts made to use science towards human welfare.
- is prepared to reconsider his own judgements.
- arranges the apparatus, materials, etc. in their proper places at the end of the work.
- suspends judgement in the absence of sufficient data.
- is free from superstitions.
- is objective in his approach.
1.6 FACTORS INFLUENCING THE DEVELOPMENT OF ATTITUDES

1. Maturation

While the formulation of attitudes is unquestionably conditioned by experience, the effect of environmental stimuli is conditioned by prior organic growth. This applies not only to the growth of the nervous system but also to the growth of the entire body. The crippled and undersized boy of sixteen years is unlikely to form the same attitudes as those formed by another boy of sixteen who is large, well proportioned, and strong for his age. Age and sex are important factors in determining just what attitude responses will be made to a given environmental situation.

On the intellectual side, attitudes are conditioned by the growth of intelligence. Development of attitude will depend on memory, understanding and reasoning. The young child has only a very limited capacity for understanding the world about him and he is consequently
incapable of forming attitudes about remote, or complex or abstract things or problems.

At about a mental age of twelve years the child begins to understand abstract terms such as pity and justice, and is capable for both inductive and continuous increase during adolescence.

At the age of four or five years, three characteristics especially deserve mention. These are curiosity, contra-suggestion and independence. The child at the age is likely to express his curiosity by asking an endless series of questions. He is trying to understand the concrete world around him, and he consequently bombards his elders with questions as to what things are, where they come from and how they operate.

At about the age of ten or twelve years, there is an increase in self-confidence which is associated with a tendency to criticize older people, both parents and teachers.

2. Physical factors

Clinical psychologists have generally recognized that physical health and vitality are important
factors in determining adjustment; and frequently it has been found that malnutrition or disease or accidents have interfered so seriously with normal development that serious behaviour disturbances have followed.

Low vitality is an important factor in producing poor social adjustment and poor social adjustment will inevitably have an important effect on the formation of attitudes in many different directions. Such children are much more likely to have anti-social attitudes and are less subject to group influences in the formation of other attitudes.

Malnutrition and disease are to a considerable extent responsible for these cases of low vitality.

3. Home Influences

It is generally accepted that attitudes are determined largely by the social environment and that home influences are especially important. In a study of infra-family similarities in attitudes, Newcomb and Svehla compared parents and children on Thurstone’s scales for measuring attitudes towards the church, towards war and towards communism. Correlation between the parents were highest, those between parents and children were next and those
between siblings were lowest. The fact that the correlations between siblings are lowest suggests, to some extent at least, the importance of outside social influences.

4. **The Social Environment**

Through social contacts, as well as through the home, the individual acquires a large proportion of his attitudes, stereotypes and prejudices.

A church group, or a social club, or a college community may come to have a particular kind of emotional and intellectual atmosphere, with the result that individual who accepts membership in the group also tends to appropriate the characteristic attitude of the group. These group influences are very strong in case of some attitudes, and, in case the schools attempt to develop attitudes that are opposed to such group-supported attitudes, the results are not likely to be encouraged.

5. **School Government**

The form of the school government seems to be an important factor in determining attitudes. In an experimental study, Lewin and Lippitt concluded that there were more tensions and more evidence of egocentric
feelings in a group under autocratic control, whereas there were more cooperative endeavour, more expression of objective attitudes and of praise and friendliness, and more constructiveness in a group with democratic control.

1.7 SCIENTIFIC ATTITUDE AND OBJECTIVES OF SCIENCE TEACHING

Rai in his Report on School Science Teaching states that the main objectives for teaching of science should be-

1. To arouse the curiosity of the student about the world we live in and to encourage him to understand the various phenomena.
2. To train to acquire the habit of making observation in a planned way.
3. To develop in him scientific attitude.
4. To give him an idea how a scientist works.

The aims and objectives of teaching general science, according to All India Seminar on Teaching of Science, should be:
1. To familiarize the pupil with the world in which he lives and make him understand the impact of science so as to enable him to adjust himself to his environment.

2. To acquaint him with the scientific method and enable him to develop scientific attitude.

3. To give the pupils a historical perspective, so that he may understand the evolution of scientific development.

The following similar set of objectives was formulated by the principals of Delhi Higher Secondary Schools in the third summer camp organized by the Extension Department of the Central Institute of Education, Delhi.

1. To develop in the student a scientific attitude.

2. To develop in the student critical thinking.

3. To enable the student to acquire the fundamentals of scientific method.

4. To develop the student to be creative.

5. To develop in the student skill in laboratory techniques.

6. To develop in the student the ability to apply scientific knowledge and principles to problems of everyday life and new situations.
7. To enable the student to comprehend scientific terms, concepts, symbols, various tables and their uses.
8. To enable the student to construct and interpret graphs, diagrams and models.
9. To enable the student to collect and interpret data for the solution of problems.
10. To enable the student to be familiar with the natural resources of his environment and their uses.
11. To enable the student to be familiar with the trends in modern science.
12. To enable the student to appreciate the beauty and order in nature.

Bhaskar Rao states that a teacher must formulate some definite objectives and specification..... in order to achieve desirable behavioural changes among pupils. He emphasizes at objectives such as knowledge, understanding, application, skill, interest, scientific attitude and appreciation.

And the latest National Policy on Education – 1986 states that ‘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'.

All the above aims and objectives of science stress directly or indirectly, the importance of scientific attitude alongwith scientific aptitude, skills, abilities and interests.

1.8 STATEMENT OF THE PROBLEM

The present study is stated as:

“A Study of Select Intellectual and Non – Intellectual Correlates of Scientific Attitude”.

1.9 OBJECTIVES OF THE STUDY

The present study is undertaken with following objectives:

1. To construct and standardize Scientific Attitude Scale for Ninth Class students.

2. To find the relationship of Intelligence and Science Achievement (Intellectual Variables) and Socio-
Economic status, Scientific interest and Home environment (Non – Intellectual variables) with their Scientific Attitude.

3. To examine the difference, if any, on account of sex, rural – urban and caste differences, type of school and also the viewing of scientific programme.

1.10 DE – LIMITATIONS OF THE PROBLEM

1. The present study was de-limited to 9th class students studying in Govt. and Model Sr. Secondary schools.
2. The study was restricted to Punjab state only.
3. The study was restricted to 740 students (Govt. school students and Model Sr. Secondary School students) selected on the basis of stratified randomisation technique.
1.11 OPERATIONAL DEFINITIONS OF THE TERMS USED

(i) Scientific Attitude:

It consists of attitude or readiness to be confident that universe is a self sustaining unit and human intelligence is capable of understanding natural phenomenon. It is readiness to accept tested human knowledge, attack problems with reason to look for true and cause and effect relationship and readiness to love knowledge for its own sake. It is readiness to have broad and versatile interests and sensitively curious. It is readiness to seek correctness in work and thinking so that truth may be discovered, to seek a factual basis for all conclusions and to avoid assertion. It is also readiness to be carefully and painstakingly accurate in all work and thinking and readiness to be orderly in all work and thinking. In other words it is curiosity, open-mindedness, faith in scientific method, to seek evidence, to be objective, suspended judgement and aversion to superstition.

(ii) Intelligence

In the present study intelligence has been operationally defined as, “The ability to deal with numbers, analogies, opposites and synonyms, to make categories, to
draw influences”. Its measurement (verbal) is the total score on Tandon’s (1971) Group Test General Mental Ability.

(iii) Science Achievement

According to Crow and Crow (1956), “achievement means the extent to which a learner is profiting from instruction in a given area of learning”. Therefore, science achievement means marks of the students in the subject of science of the preceding year.

(iv) Socio-Economic Status:

As defined by the author of the test, ‘Socio-economic status’ may be defined as “economic rank or position of the individual in a group to which he belongs. An individual’s socio-economic status is his group standing or ranking in terms of his social and financial position in relation to others”. In the present study, socio-economic status of the students is the measure of scores obtained on ‘Socio-Economic Status Scale’ by Kohli (1988).

(v) Science Interest:

According to Dubey and Dubey (1986) “interest may be defined as a tendency to choose one activity in preference to another or to seek out an activity or object.
Science interests cover such things as our preferences and diversions or likes and dislikes in the field of science”.

(vi) **Home Environment:**

Misra (1989) has identified the following characteristics of home environment: permissiveness, willingness to devote time to the child, parental guidance, parental aspirations for achievement, provision for the child’s intellectual needs, affective reward, instrumental companionship, prescription, physical punishment, principled discipline, neglect, deprivation of privileges, protectiveness, power, achievement, demands and conformity.

1.12 **NEED OF THE STUDY**

Attitudes determine the negative or positive character of our responses to various kinds of stimuli or diverse type of situations. Their importance in life cannot be overstated. Attitudes offer greater possibilities for successfulness of achievement as well as failure in life. They are an important motivator of behaviour and affect human values. “Efficiency results, when a person is impelled by his attitude to start, continue and complete a project rather than to avoid an unpleasant task. His attitude towards his work affects
his worthwhileness in the activity”. This has been given by Crow & Crow in 1991. Attitudes are important because they determine the actions of human beings. There is hardly any object, procedure or idea or occupation towards which we do not have any attitude. Prescot (1991) in his book, “Emotion and Educational Process” points out that, “Attitudes supply the code of measuring rod by which the behaviour of the individual and of others is judged”. Furthermore, attitudes supply principles on the basis of which choices are made. Attitude towards an object, idea or a thing is important in our satisfied or dissatisfied living. Attitude helps one in keeping one’s mental health. How you look at a thing is a matter of attitude and this is very important.

A number of research studies have been done on attitudes. Pareek and Rao (1973) have mentioned a large number of attitude studies, e.g. attitude towards teaching profession, attitude towards co-education, attitude towards compulsory primary education, attitude towards technical education, etc. But no study has so far been carried out for finding scientific attitude. A mention of a number of studies for finding scientific attitude has, however, been made. Sood (1974) studied that attitude towards science and scientists among students and teachers and found the understanding of
science positively related to it. Though a number of studies have been done to find scientific attitude but unfortunately, so far there has been very few studies on the nature and concept of scientific attitude. May be this because educational researchers have left this area to scientists. Srivastva (1980) has also measured scientific attitude and found the amount of scientific knowledge or general exposure to science courses made an impact on the scientific attitude. Bandopadhyay (1984) found that parent education and socio-economic status led to favourable attitude towards science, besides other contributory factors like teachers’ influence, peer’s influence, vocational value of science and future aim in life.

National Policy on Education (1986) had recommended that science education will be strengthened to develop in the child well defined abilities and values such as spirit of inquiry, creativity, objectivity and courage to question. In other words efforts will be made to develop scientific temper in children (vide para 8.18).

As National Policy on Education (1986) stressed the need of developing scientific temper in children, a special emphasis has been given to science education in
schools. But still students of science have more knowledge and exposure to science than students of arts faculty. So there must be difference in their scientific attitude. Moreover, attitudes are not developed in isolation. Rural or urban environment also affects the scientific attitude of the students. The influence of the environment on the interests, attitudes and other characteristics of personality has been systematically studied by a number of investigators but influence of home environment on scientific attitude has not for been studied.

Present study will also help the teachers, parents and educational planners to measure the scientific attitude of students with the standardized scale, prepared by the investigator in the present study.

1.13 ORGANIZATION OF THE RESEARCH REPORT

Having presented the importance and need for studying the present study along with objectives in the introductory Chapter I, Theoretical viewpoints – points about predictors have been given in Chapter II. Chapter III deals with the Review of Related Studies and Hypotheses whereas Chapter IV is devoted for the description of steps needed for
the standardization of scientific attitude scale. In Chapter V detailed account of Method and Procedure employed in the present study has been given, while the Chapter VI presents the Nature of Score Distributions. Chapter VII gives details of Analysis of Data and Discussion of Results, and Chapter VIII deals with the Summary, Conclusions and Suggestions for Further Research.

The Bibliography and Appendices have been given at the end of the Research Report.