Chapter 1

Introduction

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Education is a developmental process concerned with the whole being. The widening of interest and the cultivation of initiative do much to assure the contacts and interactions necessary to bring about this development. These interactions produce some changes in the individual's appreciations, attitudes and habits of thought and action, together with a gradual growth in comprehension of broad generalization of knowledge. These major outcomes are best realized through a series of undertaking each of which constitute a stimulating and satisfying experience. The goal of education is the fullest realization of the possibilities of the individual not only for one's personal welfare but for participation and contribution in a changing society.

Primary Education forms a very important part of entire education system as it forms the base of the individual's comprehensive development. It is sound base for secondary and higher education too. Hence it should be given the highest priority as it leads to development of competence and in turn increases national productivity.

One of the important goals of school education is the development of scientific literacy among students'. The primary school years are crucial in developing students' long term interest in science. It is vital, therefore for teachers to not only set in place the knowledge foundations for continued studies in science but also to engender in students a passion for science and an understanding of its significance, in modern society. But what we do today is transfer the product of science from one brain to another and thereby the scientific process is entirely neglected. The child nowhere undergoes the process of science. The same has been reflected by various committees and commissions.

Secondary Education Commission (1952-53) recommends that emphasis in teaching should shift from verbalization and memorization to learning through purposeful, concrete and realistic situations, and for this, the principles of activity method and project method should be assimilated.

Report of Education Commission (1964-66) stated that "We lay great emphasis on making science an important element in 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 the first ten years of schooling". The first attempt to make teaching general science as a compulsory subject upto secondary school was made in the recommendation by Secondary Education Commission (1952-53). Thus science education in schools in India is compulsory upto lower secondary level and optional at higher secondary level.

According to Education Commission (1964-66) in an average school, today instruction is dull and uninspiring as it still conforms to a mechanical routine dominated by verbalism. Education Commission (1964-66) goes on to say that, "Even where laboratory work is taught, the approach is confirmatory and not investigatory and the emphasis should shift from confirmatory to investigatory so as to equip children in the techniques of acquiring knowledge by themselves".

UNESCO's International Education Commission (1972) recommended "Science and technology must become essential components in any educational enterprise; they must be incorporated into all educational activity intended for children, young people and adults, in order to help the individual to control social energies as well as natural and productive ones, thereby achieving mastery over himself, his choice and actions and, finally, they must help man to acquire a scientific turn of mind so that he become able to promote science without being enslaved by it". The National Policy on Education (1986, revision 1992) formulated significant statements on science and mathematics education. This includes science and mathematics education will remain as core subjects in the first ten years of school education. Science upto class X should be treated as one. The laws and principles of science which are operating in the environment should be used for creating desired teaching/learning situations. The performance of activities will be given top priority in the teaching and learning of science.

Yash Pal in Report of National Advisory Committee on Learning without Burden (1992-93), observed that our textbook appears to have been written primarily to convey information or facts rather than make children think and explore. Transmission of information rather than experimentation or exploration or observation characterizes the teaching learning process in most classrooms.

Indian National Science Academy (2002), "Science education must evoke the natural curiosity of the child, the wonderment of nature. For this the education and its tool should be fashioned to the environment in which the child lives. The child should be encouraged to find one's own answers with textbooks being only a guide".

National Curriculum Framework (2005), "For any qualitative change from the present situation, science education in India must undergo a paradigm shift. Rote learning should be discouraged. Inquiry skills should be supported and strengthened. Schools should give much greater emphasis on co-curricular and extracurricular elements aimed at stimulating investigative ability, inventiveness and creativity, even if these elements are not part of external examination system".

According to report of India's first National Science Survey NSS, India Science Report (2004), "science education needs to be strengthened in terms of methods of teaching, teacher quality and infrastructure. This observation has been found valid for all regions of the country".

Emphasis on the relevance and importance of science for all students is a central feature of all curriculum documents. Science is described as being part of everyday life and an understanding and appreciation of science concepts and processes is required by all members of society if they are to be active citizens making informed decisions and contributions to debate about relevant issues and events. Various committees and commissions from Secondary Education Commission to National Curriculum Framework have recommended for science to be taught through purposeful, concrete and realistic situations and also talked of improving the quality of science education. In order to strengthen the quality of science education at all levels there seems to be an urgent need to practice learner centered activity based competency dependent inquiry approach for teaching science, which will make learning of science an enjoyable experience for children.

1.1 MEANING AND NATURE OF SCIENCE

It is not easy to answer the question what is science because the nature, structure and functions of science have been described in different forms by philosophers, scientists and theologians. But in the scientific world there are two broad views about nature of science. The view that seems to influence most layman and students is the static view which believes that science is an activity that contributes systematized information to the world. According to Mohapatra and Mahapatra (1999), Students feel that looking at the effects produced by a force on the motion of a body and then to draw generalization leading to Newton's second law of motion is science but this is not what science is. Bronowski (1956) describes that "the search for order, regularity and organization is the fundamental aspect of science". Thus, science is pictured as a structured domain consisting of interconnected sets of principles, laws and theories together with a vast array of systematized information. On the other hand according to the dynamic view, science is an activity, what scientists do and how they do. Conant

(1951) says, “In the first approximation we say that science emerges from the other progressive activities of men to the extent that new concepts in turn lead to further experiments and observations”. In the same spirit Lederman (1983) observes that science is a dynamic, ongoing activity, rather than a static accumulation of information.

The dual nature of science is reflected in Fitzpatric’s (1960) definition of science which states that “Science is a cumulative and endless series of empirical observations which results in the formation of concepts and theories, both being subject to modifications in the light of future empirical observations. Science is both a body of knowledge and acquiring and refining knowledge”. Another way of looking at this dichotomy about the nature of science is by Barrentine (1986) who states that “Science is that human activity which involves the integration of explorative and applicative modes by which one obtains an understanding of and about the world and the universe. The explorative mode of science refers to the descriptive and analytical codification of empirically validated perpetual facts resulting in a synthesis of an organized body of knowledge concerning our world and universe. The applicative mode of science refers to the prescriptive application of an organized body of knowledge, obtained by the explorative mode, which facilitates the explorative mode of science and is used for the benefits of the society”. However, science as prescribed in the curriculum, spelled out in text books and the way it is learnt by students, conforms mostly static view and at times makes an effort to integrate the explorative and applicative modes.

It is very clear from the definitions seen above that science has dual nature- the process and the product aspect. The two aspects of science are interconnected with each other and are interdependent on each other. The figure 1.1 below explains the interrelationship between the processes and products of science. The use of scientific processes are done to investigate the phenomena of nature thus leading to increased tested scientific products of facts, concepts, principles, generalizations, theories and laws. These newly acquired products are then used to broaden and increase scientific investigations which involve further use of processes resulting into new tested scientific products and thus the cycle continues till infinitum. The figures clearly show how both the process and product are interrelated and interdependent on each other.

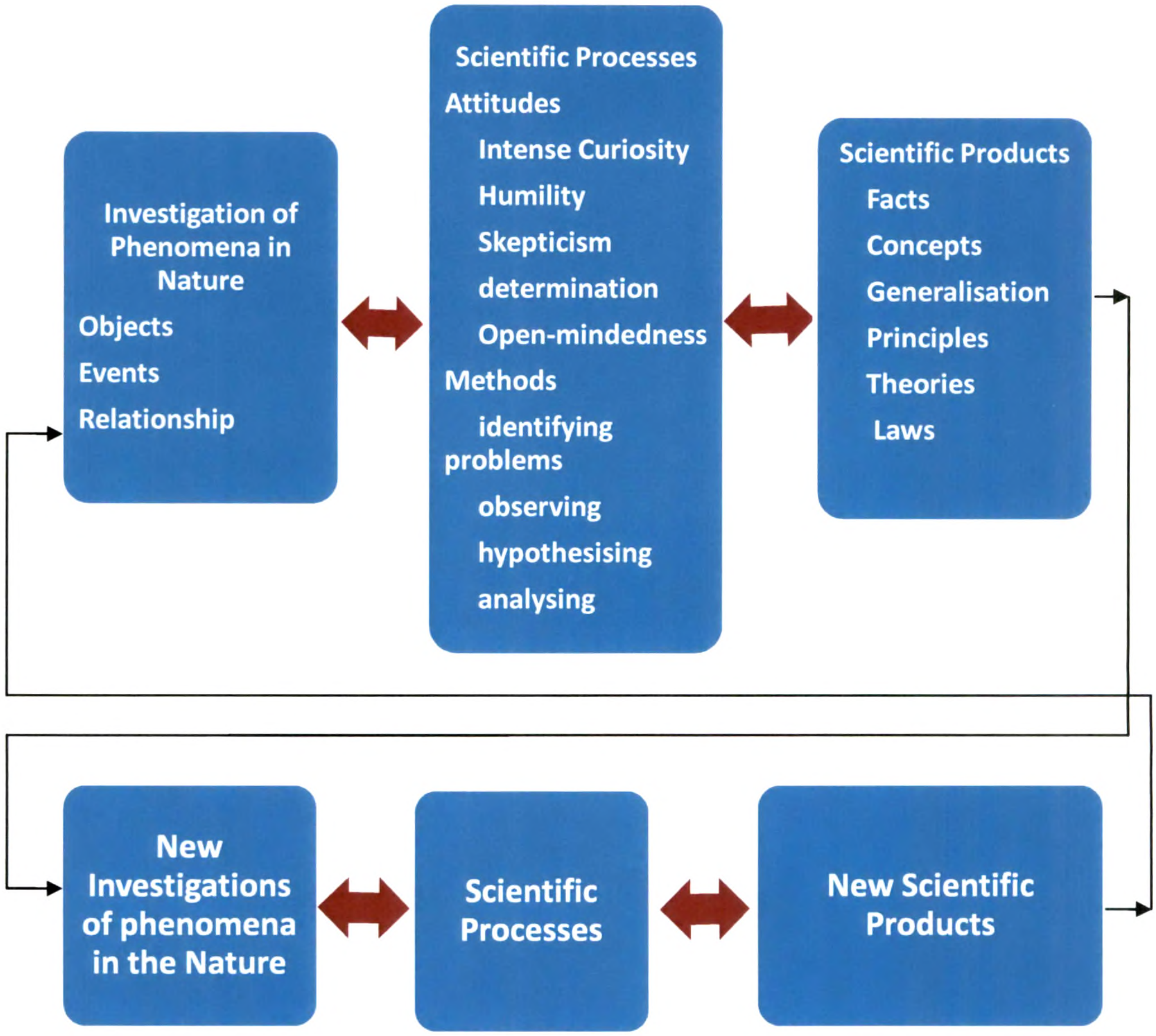


Figure: 1.1 Interrelated and Expanding Nature of Processes and Products of Science

Source: Carin & Sund (1970)

The figure 1.1.1 explains the further bifurcation of the processes and products of science. The process of science requires training in scientific methods and inculcation of scientific attitude. The classification of the products of science is depicted in the following figure in detail.

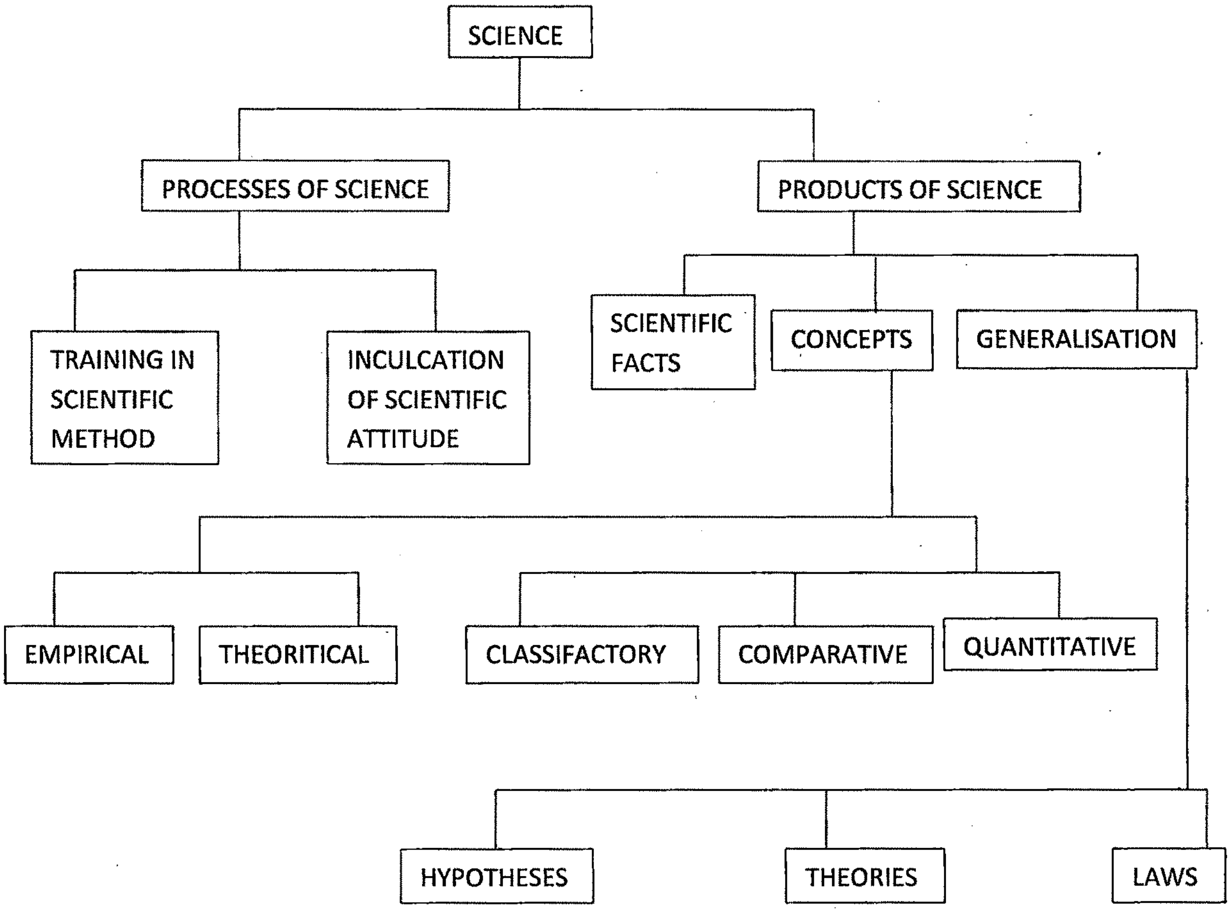


Figure 1.1.1 Further bifurcation of the processes and products of science

Scientific Products are classified into three categories as shown in the figure above. The three categories are scientific facts, concepts and generalization. Scientific facts are singular instances observed in nature. For example sun rises in the east. Scientific facts are tentative in nature and have various interpretations depending on the frame of reference. Many facts together form concepts and many concepts together form generalization. The concepts can be further classified as empirical or theoretical and the second classification is based on whether the concepts can be classificatory, comparative or quantitative.

As quoted in Carin & Sund (1970) Pavlov pointed out in a speech "Perfect as the wing of a bird may be, it will never enable the bird to fly if unsupported by the air. Facts are the air of science. Without them the men of science can never rise. Without them your theories are vain surmises". The accumulated facts gathered by scientists as an outgrowth of their studies of nature have resulted in a large body of verified knowledge. This organized and systematized subject matter is the product of scientific investigation. Schools have, however, traditionally overemphasized this product of science, the subject matter, and underemphasized or forgotten the process of science. A look at the process by which the subject matter is obtained reveals the dynamic nature of the scientific process, for facts become valid and cumulative only after they survive unrelenting scrutiny. Thus, scientific facts although extremely necessary for any scientific investigation, are only a product of the greater contribution of modern science the process of inquiry. Science is both a body of knowledge and a process. The product of scientific investigation is scientific knowledge. Unfortunately it is this aspect of science that has mainly characterized science teaching. But science is more than just knowledge. It is human enterprise involving mental operations, manipulative and computational skills and strategies that men devise to discover the nature of the universe. This human investigative aspect of science is dynamic since it evolves through the action of men as they penetrate the unknown. When a scientist questions, explores and experiments s/he demonstrates the inquiry nature of science. Unfortunately, a student learns science as a body of knowledge without understanding it as a process and without knowing what inquiry involves. Teachers have traditionally emphasized this product of science but have often failed to give students an understanding of the means of solving problems, one of the most valuable educative objectives of science instruction. The same is supported by Sund (1973) "science instruction usually has emphasized the products rather than the process of scientific research". Teachers have falsely assumed that learning the products of science will enable a student to use the processes of science. If the objectives of teaching science are to be achieved it should be borne in mind that science needs to be taught focusing on both the aspects of science- the process as well as the product. The student should be given ample opportunity to observe, explore, manipulate, estimate, predict, hypothesis, as well as measure and then come out with some findings as to why things happen as they happen. The researcher through the present study made an attempt to take care of the dichotomy about the nature of science. The researcher developed an instructional strategy for comprehension in science among the students of class VII keeping in mind both the aspects. Bolm & Peat, (1987) Science has been conceptualized as a dialectic activity involving both thought and action. The cycle of thought aspect is a part of the natural curiosity that students bring to classroom along with the rudimentary skills in inquiry. The action is represented by investigative techniques that students use in answering their questions. Taken together, these processes of thought and action will enable students to do science rather than simply read about science. The students are natural investigators and thus they bring these capabilities to classroom and therefore it is very important that as a teacher of science one understands that the task ahead is to refine the students skills and systematize students investigations and their thinking.

1.2 SCIENCE CURRICULUM AT THE NATIONAL LEVEL: A BRIEF HISTORY

According to Sharma (1984), after the imposition of imperial authority of India only those persons had access to learning modern science who studied in English medium schools. During the British period vacillations, uncertainty and aimless compromise were found both at making a school science policy and in its execution. By the mid 1950s, India had already made some attempt at examining its science education system and evolving ways to improve it. The recommendations of the Secondary Education Commission (1952-53) and the subsequent national seminar at Taradevi of the All India Council of Secondary Education had led to the introduction of general science at school level as a compulsory course. During the period of 1947-52 two views regarding teaching science were advocated. The syllabus for basic schools visualized the general science approach to teaching science at the elementary stage in an integrated way and not as a separate school subject, while another view was to teach science as systematized knowledge according to the concept approach. The debate for having the same science curriculum for rural and urban schools also continued. The teaching of science was found to be not satisfactory. Whatever was proposed to achieve could not be put into practice. One reason was inertia of the educational system. The period 1952-57 was the period when national efforts to improve secondary education were mounted. The Secondary Education Commission was against specialization and recommended a general science course that is a general introduction to all the broad and significant fields of scientific knowledge, while at the same time it desired an understanding and appreciation of the fundamental principles of science. This ambiguity in policy decision was subjected to different interpretations at the implementation stage by the decision makers at the national and state levels. Due to this, the school science education policy appeared to be bandied around from one idea to another and from one recommendation to another, leading to vacillation in policy implementation. During the period 1957- 62, the major school science curricular trend was still general science. However, the echo of the concept approach could be heard in various seminars. This happened because of the absence of proper experimentation in the field of school science education for effective planning and implementation and a clear cut school science education policy could not emerge because of parallel and continuing viewpoints on school science. The period 1962-67 was a watershed for the school science education policy. The Indian Parliamentary and Scientific Committee (IPSC) 1964 recommended the uniformity of courses and class structure as well as the upgrading of the content of science. The Education Commission (1964-66) criticized the general science approach and said that it was somewhat formless and without structure. It suggested the disciplinary approach. During the period 1967-72, efforts were mounted to implement the recommendations of the UNESCO Planning Mission (1964) and Education Commission (1964- 66). The National Policy on Education was declared in 1968 according to which emphasis was to be laid on the development of science and technology education. On the one hand, instructional materials were prepared under a UNESCO-UNICEF project in which Russian and Indian experts trained in the USSR contributed, and on the other hand instructional material were prepared by study group projects in which Indian university professors contributed under the structure of discipline movement in America. The soviet academy of sciences and the academy of pedagogical sciences had made pioneering contributions toward curriculum development and teaching in science. Again the period 1972-77 was a watershed for the school science education policy. Efforts were made to implement the recommendations of the Indian Parliamentary and Scientific Committee, UNESCO Planning Mission, and Education Commission. In 1973 the Ministry of Education appointed an expert group to prepare model curricula for ten years. These model curricula recommended that school science be taught as environmental studies at the primary stage as an integrated course at the middle stage and as integrated groups of subjects at the high school stage. The environmental study programme was tried at national level and at regional level. The guide prepared for teachers of the Municipal Corporation of Delhi observed that any environmental study should include some of the skills and knowledge of history, geography and science. So the environmental studies concept became much more formless and diffused than the general science concept. At the middle stage the syllabus was based on the unit approach. However, some units were also based on correlation of ideas from different disciplines and some units were based on a fused curriculum. This was done due to a compromise between the decision makers who desired a national policy as well as maintaining the autonomy of states and local bodies. The same thing happened at high school stage. Thus no concerted effort at formulation of a clear cut and consistent school science education policy was made during all these years.

According to National Focus Group on Teaching of Science (2006), Compulsory teaching of science, as a part of general education up to Class VII or VIII, had been in practice in most of the states and Union Territories UTs before the introduction of a uniform pattern of school education in 1975. During this period the subject was usually taught as general science in most of the states. However, at the secondary stage science was an optional subject, which was offered either as a combination of physical science and biology or as physics, chemistry and biology. The syllabus of science and textbooks were prescribed by the respective state agencies. The content and process of science teaching in schools, therefore, varied from one state to another. The general objectives of science teaching identified for Classes I–VIII during the 1960s have been basic to the evolution of science education in the country, particularly at the elementary stage. The major objectives identified were:

- to acquire knowledge of biological, physical and material environments including forces of nature and simple natural phenomena, and
- to develop scientific attitudes such as objective outlook, spirit of enquiry, truthfulness and integrity, inventiveness, accuracy and precision, avoiding hasty conclusions on insufficient data, respect for the opinions of others.

The instructional material developed by the National Council of Educational Research and Training (NCERT) under UNICEF aided project, during 1967-70 was based on an activity-based approach to the teaching of science at the primary stage. The package of instructional material comprising syllabus, textbooks titled "*Science is Doing*", handbook of activities, teachers' guides, science kit and audio-visual material were developed through a process of trial in a limited number of schools. The instructional package developed for the middle schools, Classes VI to VIII, too comprised similar components and was also developed through field trials. The science curricula developed in the NCERT were implemented mainly through the Central Board of Secondary Education (CBSE) and the schools affiliated to it. But the CBSE caters to only a very small section of the Indian school going children. Desai (1974), the bulk of the children attend the schools affiliated to various state boards of education. The state boards have been rather slow in accepting the curriculum reforms suggested by the NCERT. The time lag in this regard has been to tune of fifteen years in some states. A few states which have gradually revised the science curricula partly in the directions set by the NCERT, have not been able to provide other infrastructural conditions like physical facilities and appropriately updated inservice teacher training system as well.

The Education Commission has been an important landmark for its depth and expanse of vision of education in India. This led to the introduction of the 10+2+3 pattern of education in 1975. A National Curriculum Committee gave recommendations and guidelines for the new pattern through a policy document titled 'The Curriculum for the Ten-Year School - A Framework. Some of the main recommendations contained in the 'Framework' (1975) that had a direct implication on the teaching of science, its syllabi and textbooks were:

- all subjects including science and mathematics were to be compulsory for all students up to Class X, as a part of general education,
- at the primary stage, science and social sciences were to be taught as a single subject: 'Environmental Studies',
- an integrated approach was to be followed for the teaching of science at the upper primary stage as opposed to disciplinary approach that was then in vogue, and
- science was to be considered as one composite subject at the upper primary and secondary stages.

For Classes I and II there was to be only a 'Teachers' Guide' and no textbooks, while separate textbooks in science and social studies were prepared for Classes III to V. A set of common themes was selected for teaching of 'Environmental Studies' (science) in Classes I to V to follow a spiral approach for introducing the concepts in a graded manner.

The major guiding factors for the nature and scope of teaching science as an integrated course at the upper primary stage were that:

- science is one; different disciplines of science are only tentative compartmentalization of the subject to facilitate the study of its different aspects; the integrated curriculum should highlight this unified nature of science,
- curriculum should attempt to link teaching of scientific principles with daily life experiences of the learners,

- science curriculum should stress more on the processes of science than the product,
- teaching of science should lead to development of certain values,
- curriculum should provide enough opportunities to learners to attain some basic levels of scientific literacy, and
- Curriculum should provide ample opportunities to the teachers to try and apply a variety of methods of teaching to suit the needs of learners of different backgrounds.

The approach adopted for the upper primary stage was extended to the secondary stage although a disciplinary approach was recommended for the latter. However, a Review Committee under the chairmanship of Sri Ishwarbhai Patel in 1977 recommended that science at the secondary stage should be offered through two equivalent alternate courses. The 'Course B' was to be a composite course in science to be taught through a single textbook. For 'Course A', it recommended a discipline orientated approach in which physics, chemistry and biology were to be taught as separate subjects. The system of alternate courses was discontinued from the academic session 1984-1985 mainly because of the perceived superiority of one course over the other. The 'Framework' of 1975 provided general guidelines and instructional objectives only up to the secondary stage. The responsibility of identifying aims and objectives of science teaching and the development of the syllabi and textbooks for different disciplines at the senior secondary stage was given to the curriculum developers. The next important development was the National Policy on Education (NPE - 1986), which subsequently led to the development of the document 'National Curriculum for Elementary and Secondary Education – A Frame-Work' (NCF - 88). As before, it recommended teaching of science as a part of 'Environmental Studies' at the primary stage. It also gave specific guidelines for the two integral components of 'Environmental Studies', namely, science and social studies. The guidelines provided by the NCF-88 were further elaborated in a brochure titled 'Science Education for First Ten Years of Schooling - Guidelines for Upper Primary and Secondary Classes' (2001). The main features of the National Curriculum Framework for School Education – 2000 pertaining to science education have been:

• teaching of environmental studies as a single subject of study at the primary stage instead of environmental studies (science) and environmental studies (social science),

• teaching of 'Science and Technology' in place of 'Science' at the upper primary and secondary stages, so as to familiarize the learner with various dimensions of scientific and technological literacy

Thus, science curriculum in India has undergone several changes, both in approach and content, during the last forty years. At the primary stage, teaching of science as a single subject was first replaced by Environmental Studies (science) and subsequently by an integrated course on Environmental Studies. At the upper primary stage, the disciplinary approach was replaced first by an integrated approach to science as a single subject, and finally by an approach integrating science and technology. The syllabi and textbook development programmes at the state/UT level also followed curriculum renewal exercises at the national level. The instructional materials developed by the NCERT at the national level were adopted or adapted by some of the states/UTs while others evolved their own mechanisms. In some states science at the secondary stage is taught as a combination of physical science and biological or life science while in some others as physics, chemistry and biology or life science. However, compulsory teaching of science and environmental orientation to science teaching up to secondary stage has been a common feature in science curricula of all the states/UTs.

To summarize, major curriculum renewal programmes in science in India have evolved in keeping with contemporary global trends in science education and the changing societal needs. Yet this has not reflected in the actual quality of science teaching in schools. This has been mainly due to dilution of inputs at every stage of implementation.

1.3 AIMS OF TEACHING SCIENCE AT UPPER PRIMARY STAGE

According to Sankhala & Yadav (2006) aims of teaching science at upper primary stage are as follows:

- To help the students to get acquainted with the impact of science over the environment surrounding them and to develop their interest in the study of science.
- To provide knowledge about the basic primary facts, principles and theories related with science.

- To cultivate the habit of systematic and logical thinking.
- To develop scientific attitude among children.
- To help the students in disciplining their mental faculties.
- To develop the habit and ability of drawing correct inferences out of available facts and evidences.
- To provide essential base for further studies in higher classes.
- To acquaint the students with the history of the development of science and help them understand and appreciate the progress and development made in this sphere.

1.3.1 OBJECTIVES OF TEACHING SCIENCE AT UPPER PRIMARY LEVEL AS SUGGESTED BY VARIOUS COMMISSIONS AND COMMITTEES

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, published by Ministry of Education in 1956. The aim and objectives of teaching science at upper primary level are as follows:

Taradevi Report (1956)

- Acquisition of a kind of information concerning nature and science which may also serve as the basis for a later general science course.
- Developing the ability to reach generalizations and to apply them for solving every day problem.
- Understanding the impact of science upon our way of life.
- Developing interest in scientific hobbies.
- Inspiring children by stories about scientists and their discoveries.

Education Commission (1964-66)

- Acquisition of knowledge together with the ability to think logically, to draw conclusions and to make decisions at a higher level.

Ishwarbhai Patel committee (1977)

- Acquisition of tools of formal learning, namely, literacy, numeracy and manual skill.
- Acquisition of knowledge through observation, study and experimentation in the areas of social and natural science.
- Acquisition of skills of purposeful observation.

- Development of aesthetic perception and creativity through participation in artistic activities and observation in nature.

On the basis of National Curriculum Framework for School Education (2000) the objectives of teaching science are:

- Expose the children to basic processes of science.
- Make children understand the processes that underlie simple scientific and technological activities.
- Develop an understanding of some basic principles and laws of science.
- Make children understand applications of basic scientific principles to solve problems related to daily life.
- Develop the ability to apply appropriate concepts of science.
- Develop measurement and manipulative skills and to encourage use of locally available resources.
- Familiarize the children with life processes, health, nutrition and human diseases.
- Acquaint the children with the technology that abounds in their immediate surroundings
- Create awareness of the immediate environment and a need for its protection.
- Make children recognize the relationship of Science, Technology and Society.

National Curriculum Framework (2005)

At the upper primary stage, the child should be engaged in learning the principles of science through familiar experiences, working with hands to design simple technological units and modules (e.g. designing and making a working model of a windmill to lift weights) and continuing to learn more about the environment and health, including reproductive and sexual health, through activities and surveys. Scientific concepts are to be arrived at mainly from activities and experiments. Science content at this stage is not to be regarded as a diluted version of secondary school science. Group activities, discussions with peers and teachers, surveys, organization of data and their display through exhibitions in schools and the neighbourhood should be important components of pedagogy. There should be continuous as well as periodic assessment in the form of unit tests, term-end tests.

In brief it can be said major objectives of teaching science at upper primary level are making the children understand the impact of science upon the way of life, inspire them by stories about scientists and their discoveries, provide the students the skill of purposeful observation, expose the children to basic processes of science, providing situation so that they understand the processes that underlie simple scientific and technological activities and develop understanding of some basic principle and laws of science and thereby apply the basic scientific principles to solve problems.

1.4 SCENARIO OF TEACHING SCIENCE

The actual picture of science teaching and learning is one of great variability but, on average, the picture is disappointing. Although the curriculum statements in general provide a framework for a science curriculum focused on developing scientific literacy and helping students progress toward achieving the stated outcomes, the actual curriculum implemented in most schools is different from the intended curriculum. Students at upper primary schools experience disappointment, because the science they are taught is not engaging them and thereby does not connect with their interests and experiences. Traditional chalk-and-talk teaching, copying notes, and "cookbook" practical lessons offer little challenge or excitement to students. Studies of teaching practices in science and technology education across primary and secondary indicates that behaviorist, transmission, whole class teaching, in which the teacher is the expert and the student is merely a passive recipient of knowledge remained the dominant model in the teaching of science and technology. Vaidya, (1997) "science teaching has been and is still oral in character with demonstrations occasionally thrown in. There is very little practical work upto class eight. At the higher stage a prescribed list of experiments is rigidly followed by the teachers in the laboratory, which is mostly in the nature of verifying knowledge or working according to set rules, made quite explicit before introducing the real experiment to the students. The element of investigation, training in the use and practice of scientific method and even mastery of the research operation are conspicuous by their absence, even at those places where laboratory facilities and equipment are generous". Bhide, (2002), in the present system, exploration and experimentation have become extinct. Students learn science either from the blackboard or from books and not by participating in science or by doing science. Curiosity of children which is normally inborn is dampened at every moment. Einstein once said "Curiosity is like a tender plant and it dies even if slightest stress is given to it". In our schools and colleges, mortal blows are given now and then to this tender plant of curiosity. In much the same way, students are dissuaded from asking questions and they have to learn science as if coming from Vedas or scriptures. Asking a question is the first and the most important step in the process of acquisition of knowledge. It must be realized that when a student asks a question, s/he not only expresses her/his ignorance but more importantly expresses desire to know the answer. It must be recognized that at the root of every major discovery in science there was someone who asked a fundamental question. Kumar (2004) the director of Homi Bhabha Centre for Science Education (HBCSE), "It is unfortunate that majority of schools across the country teach science in boring and mechanical style allowing little room for original thinking and innovation. Most of the time of the student is spent on searching for the correct answer. This is a false interpretation of science teaching. Science is all about doing and learning even through mistakes. It's vital that the interest in science is kindled and nurtured through the school years because it's from school system that our future scientists and technologists will emerge. We must catch them young".

According to Chunawala (2006) in sixth survey of Educational Research, "In India, as in several countries learning science is not as popular as it should have been. A few students choose to continue with science into higher education and to a career. Science in schools is often criticized for being too prescribed, impersonal, lacking in opportunity for personal judgment and creativity. Science has reduced to a series of small, apparently trivial activities and pieces of knowledge unrelated to the world in which students are growing up". Science teaching has been dominated by the transmission of facts, the 'tyranny of abstractions' (dominance of abstraction) and the clutter of 'inert ideas'.

National Curriculum Framework (2005), "Looking at the complex scenario of science education in India three issues stand out. First science education is still far from achieving the goals of equity enshrined in our constitution. Second, science education in India, even at its best, develops competence but does not encourage inventiveness and creativity. Third, the overpowering examination system is basic to most, if not all, the fundamental problems of science education in India".

1.5 REVISED TEXTBOOK OF SCIENCE AND TECHNOLOGY

On the basis of recommendations of NCF (2005) there has been revision of textbook in the state of Gujarat. The state has revised the textbook in phased manner. The revision of the textbook of class V and VI was done followed by the revision of the textbook of class VII. The revised textbook of science and technology for class VII is been implemented in all the primary schools of the Gujarat state from the academic year 2008-2009. There are a total of twenty three chapters in the textbook. These chapters have been further divided into five field of studies viz., (i) science in everyday life (ii) living kingdom (iii) preservation of environment (iv) water, air, soil, sky and energy and (v) food and health. Expected learning outcomes have been listed as Minimum Levels of Learning (Appendix A). Same can be seen in concise in the following table:

Table: 1.1
Five field of study along with Minimum Levels of Learning

Sr. No.	Field of Study	Number of learning outcomes
1	Science in Everyday Life	1.7.1 to 1.7.29 (29)
2	Living Kingdom	2.7.1 to 2.7.20 (20)
3	Preservation of Environment	3.7.1 to 3.7.4 (04)
4	Water, Air, Soil, Sky and Energy	4.7.1 to 4.7.24 (24)
5	Food and Health	5.7.1 to 5.7.4 (4)

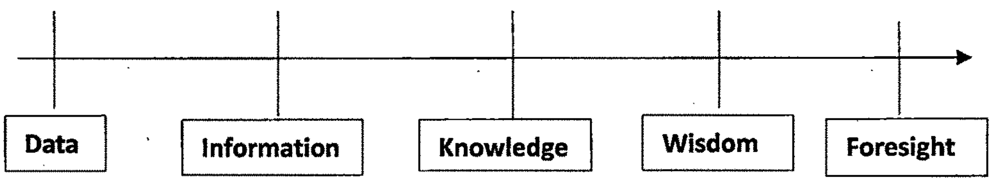
The major focus of learning outcomes is on knowledge level only. There are very few outcomes based on comprehension/understanding. Along with the revision in the textbook the state has also prescribed journal incorporating certain experiments to be included in the syllabus. According to National Focus Group on teaching of Science (2006) though activity-based teaching has been accepted as a paradigm for science education and is also reflected in some measure in the textbooks developed at the national and state levels, it has hardly been translated to actual classroom practice. Activities still tend to be regarded as a way to verify the ideas/ principles given in the text, rather than as a means for open-ended investigations. The researcher analyzed the textbook of class VII thoroughly and is of the opinion that though the textbook board claims to incorporate activity based learning on the lines of the recommendation given by NCF (2005), the textbook still is not making the students take the role of the constructor of knowledge as the content presented in the text book is not providing scope to the students to explore while conducting activities, hypothesize, predict, estimate, measures as the textbook consist of the explanation as to what will be the outcome given a situation.

1.6 NEED FOR COMPREHENSION IN SCIENCE

Yash Pal in NCF (2005) "We have bartered away understanding for memory-based, short-term information accumulation. This must be reversed, particularly now that the mass of what could be memorized has begun to explode. We need to give our children some taste of understanding, following which they would be able to learn and create their own versions of knowledge as they go out to meet the world of bits, images and transactions of life. Such a taste would make the present of our children wholesome, creative and enjoyable; they would not be traumatized by the excessive burden of information that is required merely for a short time before the hurdle race we call examination". Yash Pal further adds "Education is not a physical thing that can be delivered through the post or through a teacher. Fertile and robust education is always created, rooted in the physical and cultural soil of the child, and nourished through interaction with parents, teachers, fellow students and the community. The role and dignity of teachers in this function must be strengthened and underlined. There is mutuality to the genuine construction of knowledge". Science has been considered as a major vehicle for enhancing the quality of human life. The effectiveness of any scheme of science education is shown by the place science takes in everyday life. Science and technology contribute effectively to the society. Science is important in everyone's life whether one knows it or not but is directly affected by it. Hence to avoid knowledge and understanding of science is to give up the right to make knowledgeable decisions about science and therefore about one's life in a society that is deeply affected by science. The purpose of science education is to develop scientific literacy which is a high priority for all citizens, helping them to be interested in, and understand the world around them, to engage in the discourses of and about science, to be skeptical and questioning of claims made by others about scientific matters, to be able to identify questions and draw evidence-based conclusions, and to make informed decisions about the environment and their own health and well-being. But the harsh reality is that the programme of science in many schools stops with parrot-like repetition of facts and principles that have been memorized to receive credit for school, but it is not enough merely to know the concept of science rather the students should understand them so that they are able to apply the same in future. Survey conducted by Wipro along with the educational initiative in five metro cities on 142 schools over 32,000 students revealed that students were not able to answer questions dealing with understanding and application level. The study was conducted on the IV, VI and VIII standard students. The selected schools have record of toppers in board examinations. (Source: Educational Initiative, 2006). Blooms taxonomy (1956 & Revised 2001) suggests that higher level objectives will be reached by students only if the lower level is mastered. The knowledge level is the lower most sublevel under cognitive domain and then comes comprehension, understanding in the revised version. The researcher feels that students are not able to respond to application level question because of lack of comprehension or understanding. When we reflect on the aims of teaching science at upper primary level like cultivating systematic and logical thinking, developing scientific attitude, drawing correct inferences and objectives of teaching science like understanding processes that underlie simple scientific and technological activities, understanding some basic principles and laws of science, understanding application of basic principle to solve problems related to life, ability to apply appropriate concepts of science and expose children to basic processes of science. These aims and objectives will only be achieved if students are able to comprehend science thoroughly. In order that the students are able to comprehend science thoroughly there is a need to change from traditional way of teaching science to teaching science where student is at focus. To strengthen the quality of science education at all levels there seems to be an urgent need to practice learner centered activity based competency dependent inquiry approach for teaching science, which will make learning of science an enjoyable experience for children.

According to Hornby (1974) Comprehension is defined as the mind's act or power of understanding. Comprehension is defined as the ability to grasp the meaning of material. This may be shown by translating material from one form to another that may be translating from words or numbers by interpreting material explaining and summarizing and by estimating future trends by predicting consequences or effects. Comprehension in the revised blooms taxonomy is called as understanding there by meaning, constructing meaning from oral, written and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing and explaining. Comprehension in science is the understanding of student about a particular principle, law, theory, fact. What does it convey? Where is it applicable? How will it be applied in day to day life? What will be its effect? What images do students possess or hold about science-principle, law, theory, fact? Comprehension in science can be achieved by making students involve in classifying, describing, measuring, experimenting, organizing and drawing conclusions. Comprehension in science will only be possible when science is taught focusing both the aspects of science the process as well as the product. In order that students understand both the aspects of science teachers need to provide appropriate exposure to the students so that they move towards higher level of understanding on the cognitive understanding scale.

Cognitive Understanding Scale: The five point scale of understanding is depicted below. Of course, this Cognitive Understanding Scale is not an equal interval scale, and one can argue that the points on the scale are only vaguely related. The left end of the scale corresponds to rote memory with no understanding. The right end of the scale corresponds to having deep understanding, using critical thinking, and doing a careful analysis of the possible consequences of one's actions. When helping a student to learn, teachers want to help the students learn over the full range of this scale. However, teachers tend to test student learning much closer to the left end of the scale than to the right end of the scale.



Moving towards increased understanding

Data: Raw, unprocessed facts and/or figures, often obtained via use of measurement instruments.

Information: Data that has been processed and structured, adding context and increased meaning.

Knowledge: Ability to use information tactically and strategically to achieve specified objectives.

Wisdom: Ability to select objectives that are consistent with and supportive of a general set of values, such as human values.

Foresight: Ability to accurately predict outcomes of one's proposed decisions and actions.

Figure: 1.2 Cognitive understanding Scale
Source: http://iae-pedia.org/image:data_5-part.jpeg

Millar & Osborne (1998) Education, at the end of the 20th century, no longer prepares individuals for secure, lifelong employment in local industry or services. Rather, the rapid pace of technological change and the globalization of the marketplace have resulted in the need for individuals who have a broad general education, good communication skills, adaptability and commitment to lifelong learning. An advanced technological society will always require a supply of well-qualified research scientists, but this requirement will be met, as at present, by educating and training only a small minority of the population. On the other hand, the ever-growing importance of scientific issues in our daily lives demands a populace who have sufficient knowledge and understanding to follow science and scientific debates with interest, and to engage with the issues science and technology poses—both for them individually, and for our society as a whole. Without a fundamental review and reconsideration of the aims and content of the science curriculum, what is offered to young people is in danger of becoming increasingly irrelevant both to their needs and those of society.

1.6.1 Paradigm shift in teaching science

Indeed the task of teaching science at the school level is now more complex than ever before since its excitement and diverse possibilities must now be infused into the young minds in an appropriate dynamically evolving way. This demands that the entire gamut of teaching science has to change from its conventionality. The conventional way is picturised and practiced as a "passive process" Gilbert and Watts (1983) of gaining and storing a specific quantum of knowledge in the form in which it is presented. In this format even performing practical is prefixed with prescriptive instructions. The student is playing role more as a robot than as an evolving, thinking being. As contrasted to this conventional approach teaching of science is now seen more as a journey than the attainment of goal, a journey that the student has to take himself/herself with perhaps the assistance of the teacher. The philosophy goes a step further and makes the statement "the knower constructs his/her knowledge" Devries and Kohlberg (1987) and learning of science then becomes an "active process" of construction.

Psychologists have determined that although students' learn in different patterns and rates, a generalized process of learning can be charted. This process of learning is as shown in figure 1.3. Sensations develop an awareness of stimuli without much interpretation. Students screen and select stimuli which helps to produce percepts. Percepts are what are known about an object, quality or a relationship as a result of sensations. Percepts are fabric from which concepts are formed. Many percepts together form concepts. Concepts are abstractions which organize objects and events into categories and from these concepts are the scientific principles or generalizations arrived at. Generalizations or principles are concepts involving relationships between two or more abstractions, objects, events.

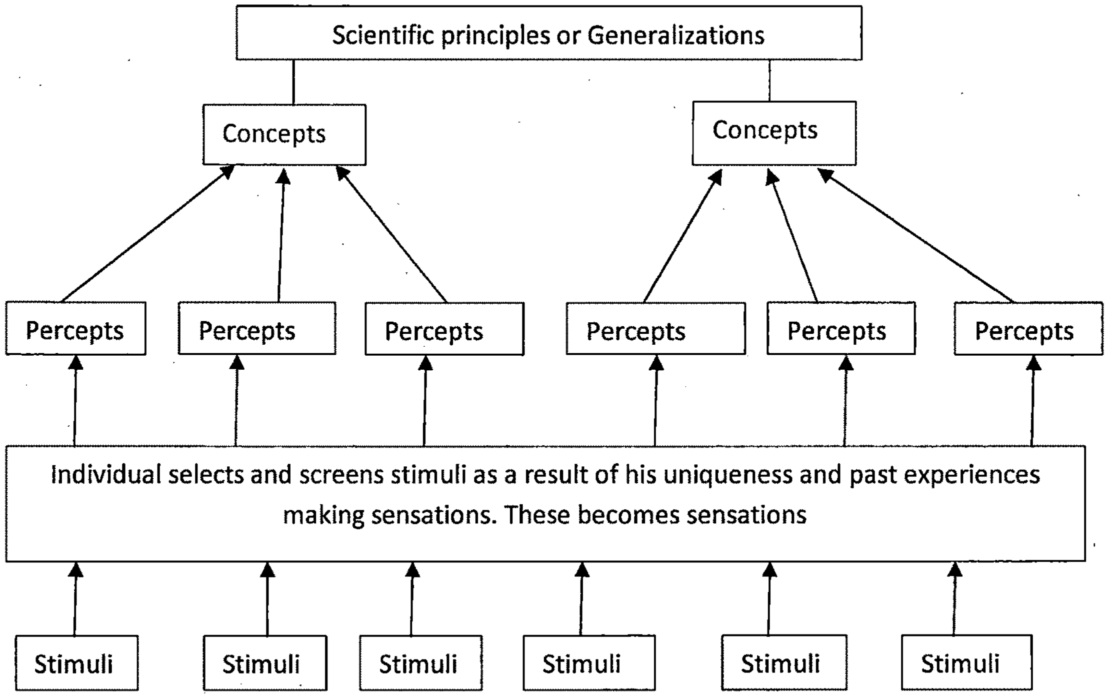


Figure: 1.3 Interrelationships and directions of the different aspects of learning [Chart modified from Charlotte Crabtree and Fannie Shaftel (1963)]

Students develop knowledge and ideas in science which make sense to them by linking new information to their existing conceptual frameworks. Importantly, this new information is incorporated into existing mental structures in ways that are meaningful to the students, it is not written on a "clean slate". Thus students' prior knowledge and experiences are crucial determinants of what their new knowledge and understanding will be like (Osborne & Wittrock, 1983). Each student has a unique set of experiences from which his personal knowledge is constructed. It is that personal knowledge and the student's unique perspective that is engaged when the student pursues an investigation and creatively constructs personally satisfying explanations. Ebert & Ebert (1993) the patterns discovered and relationships perceived are bound to vary from one student to another. After all learning is a creative endeavor that involves the search for patterns, perspective and relationships. Harlen & Elstgeest (1992), the understanding of the world around depends on the development of concepts, but this development depends on the use of the process skills. The two are interdependent as concepts gradually become more sophisticated, so process skills need to be refined and extended. Development of both must go hand in hand. It may be helpful to represent the linking of ideas to new experiences by the following diagram:

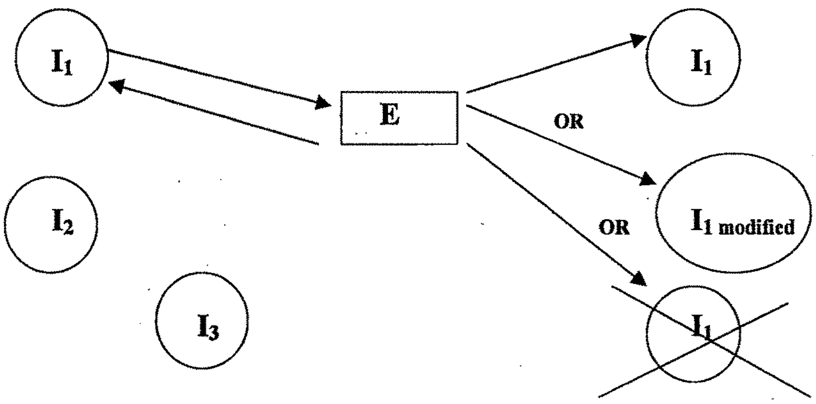


Figure 1.4 linking of ideas to new experiences
Source: Harlen & Elstgeest (1992)

The circles I_1 I_2 and I_3 represent various existing ideas and E represents a new experience. One of the existing ideas is linked to the new experience in preference to other possibilities because of some perceived similarities. The processes involved in this may include observing, hypothesizing and communicating. The idea which has been linked is then tested against evidence to see whether or not it helps in making sense of the new experience. If it does, it will emerge reinforced as a more useful idea, strengthened by having a wider range of applications. But whether or not this happens, or whether the idea is found to need modification or should be rejected, depends on the way in which the testing processes are carried out. The testing processes include raising questions, predicting, planning and carrying out investigations, interpreting and making inferences, and observing, measuring and communicating. The process depends on the learners using and testing ideas they already have. Which one of the possibilities represented in the diagram occurs depends not only on the existing ideas and the nature of the new experience, but on the extent to which scientific process skills can be used. If the new experiences are as being one provided in school so that children can learn, then the process skills and attitudes exercise a determining influence on the extent to which conceptual learning takes place. The ideas and understanding which children achieve from an experience will depend on their ability to carry out the processes scientifically. But, like concepts, these skills and attitudes have to be developed gradually.

Harlen & Elstgeest (1992), "We need not linger long on the faults of rote learning, but it is worth observing that much science was and probably is taught in a way which leaves pupils little option but to learn facts by heart. This leads to science being regarded as a mystery, as not making sense and has nothing to do with understanding the world around, which is surely the aim of our science education". Just as, progress in science has come from one small advance after another, new and better instructional programmes are built a little at a time, one small innovation after another, a new experiment undertaken a child invited to report what s/he has observed or a new idea from a professional book added to the teachers' expertoire.

Teaching learning of science since 1950 has been an immensely meaningful journey through three paradigms. 1950 saw the gradual decay of the transmissionist approach which was an operational outcome of empiricist inductivism, the nucleus of behaviouristic psychology. With the sudden appearance of the first man made satellite, sputnik one in orbit the western world woke from a state of blissful contentment about the utility and learnt knowledge output value of teaching learning of science as was then practiced inside the classroom. By 1960 the frantic searches and researches for better and alternative methods of teaching learning of science had taken a very concrete shape and may be called as cognitive approach supplemented by the activity based approach. The former was guided by the works of Piaget, Bruner, Ausuble, Suchman and others and later was formulated on the Chinese dictum "I listen I forget, I see I remember, I do I understand". However by 1980 it was strongly felt by both the cognitive psychologists and the science educationists that though their approach is perhaps right still a relook research is necessary to diagnose how does a child learn? It was soon realized that the child constructs his/her knowledge and the constructivist approach gradually acquired the centre stage. However this paradigmatic evolution of the process of teaching learning science has one connecting link between the various epochs. The link is the content to be transacted inside the classroom.

1.6.1.1 Initiatives taken to improve the quality of science education

The learner centered science education programme, based on the principles of learning by doing, learning from environment and learning by discovery was carried out under the umbrella of three well known educational institutions of Gujarat from June 1993 till 1998 under the title of Adyeta kendri Vigyan Shiskshan Karyakaram (Aveshika). The work was carried out at three well known institutions of Gujarat, namely, Gandhi Viyapith at Vedcchi, the Gujarat Vidyapith at Ahmedabad and Lok Bharati at Sanosra, Bhavnagar district with the coordination and support of the Vikram Sarabhai Community Science Centre, Ahmedabad. Under the auspices of the said programme, innovative learning and teaching material was developed and alternative text, viz, Prayog Karine Vigyan Sikhiye, for standard V, VI and VII were generated. Major portions of this text material have been incorporated by the Gujarat State Text Book Board in their science text books of standard V, VI and VII for all the schools of the state. However this is not sufficient because innovative text material alone does not make science education completely meaningful in schools, unless and until the teachers themselves undertake all the necessary experimental activities in their classroom along with a definite change in the process of teaching learning.

Another such innovative programme was taken up by Hoshangabad Science Teaching Programme (HSTP), a programme for teaching middle school science through experiments, which started in 1972 as a pilot project in 16 schools of Hoshangabad district in Madhya Pradesh. The HSTP is unique as it was a state programme running in ordinary government schools, supported by a large academic resource group. Mukerjee (2007), "A sad commentary on school education in India is provided by the closure of the HTSP by the Madhya Pradesh Government. Plea by educationists across the country fell on the deaf ears. Essentially, it was a victory for forces that resist change and want to preserve the status quo".

1.7 RATIONALE OF THE STUDY

Today's age is the age of Science and Technology. Right from cradle to 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. Science is important in everyone's life whether one knows it or not but is directly affected by it. Hence to avoid knowledge and understanding of science is to give up the right to make knowledgeable decisions about science and therefore about one's life in a society that is deeply affected by science. The purpose of science education is to develop scientific literacy which is a high priority for all citizens, helping them to be interested in, and understand the world around them, to engage in the discourses of and about science, to be skeptical and questioning of claims made by others about scientific matters, to be able to identify questions and draw evidence-based conclusions, and to make informed decisions about the environment and their own health and well-being. This being the situation it becomes very important that all the primary school children not only be aware about the basic concepts of science but possess thorough understanding of concepts, principles, facts and theories of science. The rapid advancement of science and technology and increasing need for scientist and technologists have made it all the more important to provide for science base education in the school. The primary school days are the foundation for further study and therefore vigorous methods and approaches for cultivation and promotion of science should be adopted.

In the world of today where knowledge is being multiplied exponentially, science education will not be able to justify itself by remaining merely contented with the objective of imparting a certain quantum of scientific knowledge, however large be the quantum. Since the rate at which knowledge gets obsolete is very high and therefore it is essential that the emphasis of science education should be on the development of abilities and disposition of mind rather than merely the transfer of dead subject matter. Thus science education if properly conceived should primarily be concerned with the education of mind rather than acquisition of isolated pieces of scientific knowledge. The curriculum must enable students to put their views, to ask questions and to do mistakes learn from those mistakes and to pursue investigation, share their experience with school knowledge and relate it with world outside instead of ability to reproduce textual knowledge.

In India as reported by Kurrien (2007), it is observed from a large scale study that the students performed poorly in questions testing understanding or application of knowledge to new situation and majority of students were unable to answer questions that appear to be different from what they typically encountered in their books. Studies of teaching practices in science and technology education across primary and secondary indicate that behaviorist, transmission, whole class teaching, in which the teacher is the expert and the student is merely a passive recipient of knowledge remained the dominant model in the teaching of science and technology. NCF (2005) it is harsh reality that children's voices, their experiences hardly find place in the classroom. Often the voice heard is that of the teacher and even when students speak that is only to respond to the question raised by teacher or repeating teachers' words. Students are rarely given opportunities to do things nor do they have opportunities to take the initiative. The same is supported in the study by Umashree (1999), where in it was found that of classroom observation of 240 lessons in secondary science in 185 cases (seventy seven percentage) the lesson was introduced by simply writing the topic on the blackboard and recounting the previous days lesson. Eighty percentage of the classes observed revealed the fact that the students participated only as a passive listener. The student participation if any was limited to seeking clarification on the teaching point. The teachers also felt that when it comes to examination, the students are expected to reproduce some sections of scientific information contained in the textbook, and hence they did not see the essentiality of conducting discussion sessions or participatory sessions. Even Malhotra (2006) holds similar views stating that "teachers often provide lecture and students largely observe the teacher rather than actively participating in the classroom".

According to American Association for the Advancement of Science (AAAS 1990), Science teaching that attempts solely to impart to students the accumulated knowledge of a field lead to very little understanding and certainly……. Science teachers should help students to acquire both scientific knowledge of the world and scientific habits of mind at the same time. Haury (1993) if the students are to gain an appreciation for science and compete in a scientific and technical society, they will need to be provided with a curriculum that promotes active learning, problem solving, raising questions, and seeking ways to solve their questions. Inquiry based science is an effective means to enhance scientific literacy and positive attitudes toward science. Although inquiry is no panacea, it is one more strategy teachers can use, at the appropriate time, to engage students in investigations and satisfy their curiosity for learning. Shore (1998) "We are born doing science. By randomly touching objects and placing them in our mouth, we learned as toddlers what is hot or cold, sweet or sour, sharp or dull, rough or smooth. We learned almost everything through inquiry. Watching toys sink or float in the bathtub was (rather is) a chance to investigate the principle of buoyancy. By playing catch, we made discoveries about gravity and trajectories. By building towers out of blocks, we explored principles of size, scale and centre of mass. But unfortunately, somewhere along the way we lose our curiosity about the world. It seems to happen when we are faced with our first science class. Science becomes list of facts and formulas to memorize. Our natural instincts to do inquiry are suppressed".

In January 1998 the National Science Teachers Association (NSTA) adopted its position statement, the National Science Education Standards (NSES): a vision for the improvement of science teaching and learning. In that statement, the NSTA strongly supports NSES by asserting teachers regardless of grade level should promote inquiry based instruction and provide classroom environments and experiences that facilitate students' learning in science….. professional development activities should involve teachers in the learning science and pedagogy through inquiry…. and inquiry should be viewed as an instructional outcome (knowing and doing) for students to achieve in addition to its use as a pedagogical approach. In other words, both elementary and secondary school science teachers must, develop teaching competencies and strategies for providing inquiry base investigations for students.

Various Committees and Commissions have recommended for improving the quality of science teaching by moving away from behaviorist, teacher centered approach to constructivist student centered approach. As per recommendation of various commissions and committees and specially focusing to the recommendation of NCF (2005),Gujarat State Board of school textbooks has revised textbook for standard V, VI and VII where in there is scope of incorporating many activities which would help to enhance the understanding of students in the subject. The revised textbook for standard VII is implemented from the academic year 2008-2009. Though there is change in the school textbook what kind of approach, method, media, teaching aid are used by teachers is a question to ponder upon. Seventh standard is the terminal class for elementary education. At the age of eleven to thirteen students are in concrete operational stage and students of this age exhibit thinking in system rather than single bits of knowledge. Thinking is characterized by inductive and deductive approaches in reasoning and solving problems. If students at this age are served with appropriate mental food with proper instructional strategy, they may show marked level of difference in concrete operational stage which in turn may prove helpful to accomplish the task of formal operational stage characterized by hypothetical thinking and contemplate the solution based on creativity and abstract thinking.

The students have already learnt certain scientific principles over a period of six years of their elementary education which may have helped them in constructing certain concepts. Students are able to visualize and directly experience the immediate applicability, of many of concepts that they learn in science in their day to day life and surroundings. This allows them for better scope of constructing their own knowledge and understanding about many of the events, phenomenon which they observe in the environment. There is a dire need felt to find out what students think about science, what is their comprehension about different scientific principles, facts and theories. Primary stage students are at the level of formation of basic concepts and therefore if the comprehension of students about science is found and accordingly strategy is developed that the comprehension of students is strengthened then that would prove to be excellent help as the primary education is the base for secondary and higher education too.

1.8 STATEMENT OF THE PROBLEM

Developing an instructional strategy and studying its effectiveness for comprehension in science among class VII students

1.9 OBJECTIVES OF THE STUDY

1. To study the teaching procedure followed by the teachers in teaching science and technology with respect to:
    - Various methods, approaches used for teaching science and technology
    - Use of audio visual aids
    - Use of demonstrations in the classrooms
    - Involvement of students in performing experiments/demonstrations
2. To determine the comprehension in science of class VII students.
3. To develop and implement strategy to enhance comprehension in science of class VII students.
4. To study the effectiveness of the developed strategy in terms of comprehension in science and reaction of students.

1.9.1 EXPLANATION OF THE TERM

Instructional strategy: Instructional strategy is inclusive of the sum total of all the learning experiences provided by the researcher in order to achieve the desired educational objectives. The learning experiences designed included performing number of activities/experiments by the student either in group or individually, demonstrations, making of toys from trash or low cost material, showing of animated films, powerpoint presentation, making the students predict observe explain by providing different situations.

1.9.2 OPERATIONALIZATION OF THE TERM

Comprehension in science: Comprehension in science means understanding of students in science as a whole covering both the aspects of science, the process aspect of science as well as the product aspect of science. Comprehension in science was measured using achievement test based on the blooms taxonomy. Comprehension was also found by interacting with the students while the students were conducting the experiments/activities. Comprehension in science was also measured by using a test science comprehension of story. Score on all the tests was considered as comprehension in science.

Effectiveness: Effectiveness was measured in terms of significance of difference between pretest mean and post test mean scores of experimental group and control group on achievement test based on comprehension. Effectiveness was also measured in terms of significance of difference between pretest mean and post test mean scores of experimental and control group on science comprehension of a story. Effectiveness was also measured on the responses of the students during the implementation of the instructional strategy.

1.10 HYPOTHESES

Ho1: There will be no significant difference in the mean gain score on comprehension for chapter Motion, Force and Speed of experimental group studied through instructional strategy and control group studied through traditional method of teaching

Ho2: There will be no significant difference in the mean gain score on comprehension for chapter Lever of experimental group studied through instructional strategy and control group studied through traditional method of teaching

Ho3: There will be no significant difference in the mean gain score on comprehension for chapter Water of experimental group studied through instructional strategy and control group studied through traditional method of teaching

Ho4: There will be no significant difference in the mean gain score on comprehension for chapter Measurement of experimental group studied through instructional strategy and control group studied through traditional method of teaching

Ho5: There will be no significant difference in the mean gain score on comprehension for chapter Reflection of light of experimental group studied through instructional strategy and control group studied through traditional method of teaching

Ho6: There will be no significant difference in the mean gain score on comprehension for chapter Curved mirrors of experimental group studied through instructional strategy and control group studied through traditional method of teaching

Ho7: There will be no significant difference in the mean gain score on comprehension for all the six chapters of experimental group studied through instructional strategy and control group studied through traditional method of teaching

Ho8: There will be no significant difference in the mean gain score on science comprehension of a story thirsty crow of experimental group studied through instructional strategy and control group studied through traditional method of teaching

Ho9: There will be no significant difference in the mean score on science comprehension of a story cap seller and monkey of experimental group studied through instructional strategy and control group studied through traditional method of teaching

Ho10: There will be no significant difference in the mean gain score on science comprehension of a story clever gardener of experimental group studied through instructional strategy and control group studied through traditional method of teaching

Ho11: There will be no significant difference in the mean gain score on science comprehension of a story Foolish Donkey and clever salt merchant of experimental group studied through instructional strategy and control group studied through traditional method of teaching

1.11 DELIMITATION OF THE STUDY

The present study was delimited to Students of English Medium Schools following syllabus of Gujarat State Board of School textbook and was delimited to Vadodara city for the academic year 2009-2010. The study was also delimited to six chapters of science and technology of class VII. The study was delimited to the process skills observation, measurement, inference, prediction, communication, classification.

The present chapter discussed in detail the importance of science in every individuals life as also for primary school students. The meaning and nature of science are presented at length followed by importance of comprehension in science and need for the present study. In the chapter to follow, a detailed discussion on the studies available in the area of science education has been presented with a view of drawing the implication for the present piece of research.