Chapter One:

Conceptual Framework

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1.0 Introduction

India, on move, has its own wheels of science and technology. Fivefold growth in Literacy rate, sixteen fold rise in wheat output, forty eight fold growth in per capita power consumption, telephone connections shooting up from 1.1 million to 672 million and doctors from 0.5 per to 64 per lac population are potential indicators of the strong base and growth of science and technology in India, in the last 63 years (TOI. 2010). In this context one can recall the observation of Kalam (2006), "Today India has become one of the strongest in the world in terms of scientific manpower in capability and maturity. Hence, we are in a position not only to understand the technologies that we may have to borrow, but also to create our own technologies with extensive scientific inputs of indigenous origin. Basically we have come a long way since our independence, from mere buyers of technology to those of who have made science and technology as an important contributor for national development and societal transformation. In a world where the powers are determined by their share of the world's knowledge, reflected by patents, papers and so on, the World Trade Organizations starts to play a crucial role in the economic development. It is important for India to put all her acts together to become a continuous innovator and creator of science and technology intensive products".

Development of any nation depends on its citizens, their intellectual property and social commitment. Science and technology is one of the key determinants of development. Science and Technology can develop to the fullest if capacity of every citizen is realized to the fullest. With changing world scenario it is imperative for any developing nation to adopt and adapt to the global outlook, scientific temperament and rational thinking. Mashelkar (2000) while addressing to the gathering at Indian Science Congress has summarized the progress comprehensively as follows: "Let me sum up by recalling the new panchsheel of the new millennium, which we should launch in the year 2000. It is simply; child centered education, woman centered family, human centered development; knowledge centered society and innovation centered India. These principles if put into practice, will help India to acquire a scientific temper, edge towards a 'learning community', realize national dreams of being knowledge society and leave behind memories of underdevelopment."

Learning community and knowledge society demands efficient teaching community with proficiency in creating learning climate and rational human beings rather than stereotyped machinist products from school education. It is noted that teachers teach the way they are taught. In majority of the classrooms the teachers practice the methodologies they have experienced in past and that continues to next generation. This chain is to be broken and stereotyped production is to be restricted for creating innovation centered society. This becomes responsibility of teacher training institutions. Innovative methodologies, constructivist pedagogies and activity centered instruction are the suggested ways to achieve the panchsheels mentioned above.

1.1.1 Science, Technology and Development

While delivering the convocation address of Allahabad University (Nehru, 1946) said, " It is science alone that can solve the problems of hunger and poverty, of insanitation and malnutrition, of illiteracy and obscurantism of superstition and deadening customs, of rigid traditions and blind beliefs, of vast resources going to waste of a rich country inhabited by starving millions." For that every citizen should have scientific literacy and ability to use technology in a wise manner.

Science and technology has profoundly influenced the course of human civilization. Science has provided remarkable insights into the world around us and within. The scientific revolutions of the 20^{th} and ongoing 21st century have led to many technologies, which promise to herald entirely new areas in many fields. Science and technology have been an integral part of Indian civilization and culture over the past several millennia.

India was the fountain head of important foundational scientific developments and approaches. These cover many great scientific discoveries and technological achievements in mathematics, astronomy, architecture, chemistry, metallurgy, medicine, natural philosophy and other areas. A great deal of this traveled outwards from India. Equally, India also assimilated scientific ideas and techniques from elsewhere, with open-mindedness and a rational attitude characteristic of a scientific ethos. India's traditions have been founded on the principles of universal harmony, respect for all creation and an integrated holistic approach. This background is likely to provide valuable insights for future scientific advances. During the century prior to Independence, there was an awakening of modern science in India through the efforts of a number of outstanding scientists. They were responsible for great scientific advances of the highest international caliber.

In the half century since Independence, India has been committed to the task of promoting the spread of science. The key role of technology as an important element of national development is also well recognized. The Scientific Policy Resolution of 1958 and the Technology Policy Statement of 1983 enunciated the principles on which the growth of science and technology in India has been based over the past several decades. These policies have emphasized self-reliance, as also sustainable and equitable development. They embody a vision and strategy that are applicable today, and would continue to inspire us in our endeavors. Today we have a sound infrastructural base for science and technology. This was possible due to the encouragement and support of the government and educational institutions. These include research laboratories, higher educational institutions and highly skilled human resource. Indian capabilities in science and technology cover an impressive range of diverse disciplines, areas of competence and of applications. India's strength in basic research is recognized internationally. Successes in agriculture, health care, chemicals and pharmaceuticals, nuclear energy, astronomy and astrophysics, space technology and applications, defense research, biotechnology, electronics, information technology and oceanography are widely acknowledged. Major national achievements include very significant increase in food production, eradication or control of several diseases and increased life expectancy of citizens.

While these developments have been highly satisfying, one is also aware of the dramatic changes that have taken place, and continue to do so, in the practice of science, in technology development, and their relationships with, and impact on, society. Particularly striking is the rapidity with which science and technology is moving ahead. Science is becoming increasingly inter- and multi-disciplinary, and calls for multi-institutional and, in several cases, multi-country participation. Major experimental facilities, even in several areas of basic research, require very large material, human and intellectual resource-integration. Recent launch of different country satellites by Indian space crafts stands as an example.

1.1.2 Impact of science and technology on society

Science and technology have become so closely intertwined, and so reinforce each other that, to be effective, any policy needs to view them together. The continuing revolutions in the field of information and communication technology have had profound impact on the manner and speed with which scientific information becomes available, and scientific interactions take place. Science and technology have had

unprecedented impact on economic growth and social development. Knowledge has become a source of economic might and power. This has led to increased restrictions on sharing of knowledge, to new norms of intellectual property rights, and to global trade and technology control regimes. Scientific and technological developments today also have deep ethical, legal and social implications. There are deep concerns in society about these. The ongoing globalization and the intensely competitive environment have a significant impact on the production and services sectors.

Because of all this, our science and technology system has to be infused with new vitality if it is to play a decisive and beneficial role in advancing the well being of all sections of our society. The nation continues to be firm in its resolve to support science and technology in all its facets. It recognizes its central role in raising the quality of life of the people of the country, particularly of the disadvantaged sections of society, in creating wealth for all, in making India globally competitive, in utilizing natural resources in a sustainable manner, in protecting the environment and ensuring national security. "Education has always been important but, perhaps, never more so, in man's history than today. In a science based world, education and research are crucial to the development process of a country, its welfare, progress and security." As mentioned in the Report of Education Commission (1966). Nehru (1956) observed "In the democratic country like India in order to foster democracy, every citizen of it should have scientific temper." The above mentioned statements emphasized the significance of science education. How ever, one needs to look into the science education at the basic level, to begin with.

1.1.3 Importance of science as a school subject

The first attempt to include general science as a compulsory subject in secondary school was made in the recommendation of the report of Secondary Education Commission (1953) which is also known as Mudaliar Commission. The commission suggested compulsory inclusion of General Science at middle and secondary level. It also suggested diversification of courses having science group subjects as optional channels at higher secondary level. As a result of the above recommendation, science was recognized as a compulsory subject at all levels of schooling. At pre-primary level it is taught as a general subject namely environment. At primary and secondary level it is being taught as a basic science. At higher secondary level it is being offered as specialized subjects like Biology, Physics and Chemistry for science stream. It is renamed as "science and technology" at secondary level since February

2006 considering the due importance to the application part of the science that is technology. Science occupies a core place in the curriculum because of its inherent potential values. It affords knowledge of certain facts and laws and an insight into methods and data peculiar to the domain of science. Inclusion of science as a subject in the curriculum justifies the intellectual, utilitarian, vocational, cultural, moral, and aesthetic values. Besides this, science teaching imparts training in the scientific method of inquiry and aims to develop scientific attitude in the students.

As a subject, science enjoys special place at school level. It is one of the core elements in curriculum concerns as reflected in policy documents frequently. This calls for its effective teaching to the students from the very beginning, in order to create and develop interest about science amongst them. Science is given immense importance because of its unique features and very basic nature.

1.2.1 Meaning and nature of science

One needs to understand the meaning of science to know the nature of science. For a layman, science is an activity that contributes systematized information to the world. The word 'Science' has its origin from a Latin word 'Scientice' meaning 'to know'. Many people have tried to define science and given many definitions of science. Most people equate science with the inventions for betterment of material things, such as colour TVs, refrigerators, rockets and mobiles and internet. Somehow, students have been taught to view science not as a 'way of knowing' but as a benefactor of man. 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. This definition describes the static nature of science. Giving this definition Bronowski tried to characterize science as static in nature.

On the other hand, Lederman (1983) reported that science is a dynamic, ongoing activity, rather than a static accumulation of information. Similarly, Canant (1959) has said that "In the first approximation we say that science emerges from the other progressive activities of men to the extent that formation of new concept, in turn, lead to further experiments and observations." These two definitions are dealing with the dynamic nature of science. This quality is viewed not only as a practical undertaking but as the development of conceptual scheme.

Fitzpatrick's (1960) definition of science is dealing with the dual nature of science. According to him "Science is a cumulative and endless series of empirical observations which results in the formation of concepts and theories, with both concepts and theories being subject to modifications in the light of future empirical observations. Science is both a body of knowledge and acquiring and refining knowledge." According to this definition science is a combination of both processes and products, related to and dependent upon each other. When used in this way, science offers methods of inquiry useful in learning more about universe and its working.

Further, there are many who believe that science is a collection of theories and principles, facts and forms, special methods and scientific names. Science is more than a collection of knowledge. It is also the intellectual activity in which scientists are engaged. That is, science is not just a subject; it is also a pattern of methods for solving real problems, large and small, scientific and otherwise. Science is also a set of attributes about doing things and about thinking; a background in appreciations of the natural and man made environment. Certainly, science derives from previous knowledge but a scientist is called upon not simply to recite what is known, but rather to find what is unknown. From a constructivist point of view science is not the search for truth. It is a process that assists us to make sense of world around. It is a process of actively engaging students in science. It can be said that in the literal sense, science means pursuit of knowledge, but it has a wider connotation and can be said to mean knowledge of nature in the widest possible form. It includes both the product of scientific investigations and process of scientific inquiry.

1.2.2 Science as a product

The accumulated facts gathered by scientists as an outgrowth of their studies of nature have resulted in a large body of verified knowledge. This knowledge has been organized into subject matter fields; such as Biology, Geology, and Physics Chemistry etc in the form of product of science. Science as a body of knowledge includes facts, concepts, laws and principles, theories, hypothesis; generalizations etc. knowledge is available in the form of interrelated concepts, laws which as a whole support further investigation. Series of investigation generates new knowledge which again gives thrust to further investigations. Application of science product results in the forms of technological advancements.

1.2.3 Science as a process

Science is fundamentally a means of understanding why things happen as they do. Man has found in science, a process of inquiry guided by scientific attitudes and methods to find answers to man's unlimited questions. Science processes include observations, scientific inquiry, asking questions, drawing of inferences from evidence, recording observations, developing ways and means to find answers, classification and checking evidence. It involves process of measurements, experimentations, classification, verification, enjoying the evolution of thesis-antithesis and emerging as synthesis, etc. Science is more than a subject; it is a method of acquiring knowledge, generating new knowledge and verifying already existing knowledge in light with recent observations or knowledge. It satisfies and provokes curiosity of learners while taught in a desirable manner. Science teaching, desirably, needs to include imbibing scientific inquiry, together with the inculcation of knowledge about the products of science. Science thus aims at attaining the understanding of the relationship which connects the answer to the problem (Pauli, 1960).

Looking into the nature of science it becomes clear that, as far as possible, teaching of science to students should include proposing problems, refining and defining them more productively, setting up hypotheses and their testing with the help of controlled experiments, thinking out new solutions, discarding personal opinion in the light of new evidence and suspending judgment in case of conflicting evidence, discarding even the principle of authority, if found necessary, and in short, distinguishing between scientific information and popular information and believes. According to the Report of Education Commission (1966), "science as a discipline of mind and as a preparation for higher education deserves special emphasis at school level. At the secondary stage the teaching of science should be built around home technology, agricultural implements and industrial tools. The students can be oriented to experimental science by selecting topics from nature or human inventions." Science education in this context plays very crucial role.

1.3.1 Science Education in India

Various Commissions and Committees have repeatedly observed that the science education occupies a very eminent place both at school and university stage of education in India. Importance of science education and the spread of scientific temper have been appreciated for a long time in our country. Various questions raised

and perceptions held by ancient Indian thinkers of Charvaka, Sankhya, Buddha, Jain etc. school of thought stands as an example. Indian civilization, accordingly inherits rich science which is reflected in ayurveda and mathematics. This includes both ancient and medieval societies, all branches of sciences advanced from time to time in different cultures. From the Vedic times, around 3000 B.C to 1000 B.C, Indians had classified the material world into four elements viz. Earth, fire, air and water and later on fifth element was added –ether. Based on these five elements other discipline of science emerged. Different disciplines studied during ancient India were ayurveda, yoga, astronomy, physics, chemistry, mathematics, astronomy in different time periods gradually. Thus, India has a fair share in enriching the world's material culture as well as intellectual culture. Development of science education in India is presented briefly in the proceeding part of this section.

1.3.2 Science Education in Ancient Period in India

India made a pioneer headway in the field of mathematics, medicines, astronomy, agriculture and architecture till about 600 A.D. The oldest Indian scripture, Rig-Veda, which was written 4000 years ago, refers to physicians and speaks of the healing power of medicinal herbs. The concept of atom and formation of the world as discusses in the vaiseshika, one of the Upanishads, approaches the modern western thoughts, Sankhya philosophy by kapila is very much like Darwinism. The Materia medica of the Hindus embraced a vast collection of drugs belonging to the mineral, vegetable and animal kingdoms many of which have been adopted by western physicians. There were universities and colleges of international repute to transect the knowledge.

From the point of view of methods and techniques of acquiring knowledge, there was considerable development and refinement of observation. Logical analysis as a tool or refinement of idea and to arrive at generalization s, was also considerably developed. The institutions were centered on individuals, who passed on the knowledge and skills to their best disciplines only as a result most of the scientific knowledge and traditions were lost with the time. The early universities of Takshshila and Nalanda could be taken as a first step towards institutionalization of teaching and acquiring knowledge.

1.3.3 Science Education in medieval and pre independence period in India

Medieval period could not witness much progress in science education in India. The scientific knowledge and the methods and the techniques acquired from ancient India did not help science education to develop any further. The philosophy of Buddhism

(750A.D. to 1000A.D.) discouraged the development of life sciences. During medieval period scholars and knowledgeable persons went out side India and were patronized in the royal courts of west Asian and central Asian countries. This led to brain drain. These scholars carried out information, methods, techniques and concepts that actually originated in India but were modified and, systematized and introduced as new concepts of the medieval Arabic and Persian scientific traditions of west Asia and central Asia. To mention a few, Roman and Greek text on metals, Kanada's (Indian) idea about atom and atomic physics, Aryabhattas magnum opus "Aryabhattiyam" etc.

In the pre independent India science did not make significant headway during the British Period for various reasons. Before that modern science in India already marked radical change from medieval and ancient period, new branches of science had been developed, experimentation developed as a technique of acquiring information. Language of science had taken a definite shape, scientific institutions had been developed and technology made a decisive breakthrough. Developments in science and technology remained a side during the pre independence period as a result India remained far behind in the scientific and technological developments as compare to countries in the west.

Full survey of position of science teaching in secondary schools was carried out and published as a Devonshire Commission Report (1895) by Oxford University which has schools of various countries including India. It has paved the way for the inclusion of science in the school curriculum. It recommended that (a) in all public endeavor schools a substantial portion of the time allotted to study natural science, and the not less than six hours a week on the average should be assigned for this purpose; (b) school laboratory should be constructed to supply accommodation for practical work in physics as well as in chemistry. The publication of the report marked the beginning of the widespread introduction of physics and chemistry in the curriculum of boys' schools and of botany into that of girls. However this took long time to reach to India.

Thomson appointed a committee, in 1916, to inquire into the position of natural science in the educational system and a report under title natural science in education called Thomson report (1916). Many advanced courses in science were added to many schools after this. The association of science masters and the association of

women science teachers were formed in the early century. School science review, periodicals, created a good influence on the teachers as well as the public.

Commission on the Reorganization of Secondary Education (1920) was appointed and its report "cardinal principles of secondary education" held that education should contribute to: (a) health, (d) command of fundamental processes, (c) worthy home membership, (d) vocation (e) citizenship, (f) worthy use of leisure, and (g) ethical character. In its bulletin published in 1920, entitled "reorganization of science in secondary schools", the committee urged that sciences be organized and taught in such a manner that they would contribute to the seven cardinal principles, except fundamental processes. A number of methods were suggested by which this could be affected, among them being the project method, which was at the highest of its popularity at that time.

Commission on Secondary School Curriculum of the Progressive Education Association (SSCPE, 1938) in its publication, "science in general education", presented a criticism of practices in science teaching of those time and given suggestions as to how science offerings in the secondary school should be adapted to the needs of adolescents. These needs are: (a) personal living, (b) immediate personal-social relationships, (c) social-civic relationships, (d) economic relationships, and (e) reflective thinking. A committee of the secondary school examination council under the chairmanship of sir, Cyril Norwood was formed and a report was published i.e. Norwood report (1943) devoted a full chapter dealing with teaching of science.

As an effect of all the above, the Education Act (1944) came into force in April, 1945 which has meant an increase in the amount of science taught though not to the extent to which it should have been.

Science and its education developed in India during the ancient and medieval period but in the seventeenth and eighteenth centuries there was stagnation due to British rule and system of education. Few international efforts such as Devonshire committee report (1895), Thomson report (1916) and at national level Norwood report (1943) created a movement towards science and its inclusion as a subject at secondary school level in India during pre independence period.

1.3.4 Efforts to vitalize Science Education in post independent India

After independence, the first education commission, the University Education Commission (1948) was set up under the chairmanship of Dr. Sarvapalli Radhakrishnan. It recommended secondary school curriculum and syllabus. The

commission recommended the inclusion of general science as a course of study in secondary schools. Later, in 1953, Secondary Education Commission suggested compulsory inclusion of general science and mathematics as core subjects at the middle as well as secondary level.

In 1956, a thorough discussion was held on all aspects of secondary science teaching in the "All India Seminar on Teaching of Science" at Taradevi, Shimla. This seminar was the first of its kind which acquainted the students with scientific method and development of scientific attitude among the learners as one of the aims of school science. It laid emphasis on teaching science as first hand experience and creating interest among students. Considering the due importance of science education government of India constituted the "Indian Parliamentary and Scientific Committee" (IPSC, 1961) under the chairmanship of Lal Bahadur Shashtri, which was meant to study the problems of science education in schools.

The Planning Commission formed a committee in 1964, which studied the problems pertaining to science equipment, design and list of science apparatus as well as fund allotment and purchase procedure. UNESCO Planning Mission (1964) suggested improvement in science education and inclusion of science teaching as a separate discipline at the middle school stage. In 1964, a scheme was introduced for the improvement of science education which included three programmes:

1. strengthening of science laboratories
2. special training of science teachers
3. improvements of school libraries

Report of the Education Commission (1966) namely "Education and National development" has suggested that at secondary grades science should be taught as a discipline of mind and a preparation of higher education. Development of science curriculum at different stage was effectively planned. Need for teaching science right from the primary level to the university level for the development and prosperity of the nation was emphasized.

Ishwarbhai Patel Committee (1977) has reported that teaching of science should integrate the Gandhiji's principles of Basic Education. It should lead to Socially Useful and Productive Work (SUPW) rather than mere knowledge transaction.

National Policy on Education (1986) highlighted "science education programs will be designed to discover the relationship of science with health, agriculture, industry and other aspects of daily life".

According to National Council of Educational Research & Training (1990), science teaching at secondary level should be intended to develop scientific temper, scientific skills and appreciation ability of science in learner as a discipline.

In National Curriculum Framework for School Education (2000), it was reflected that "An important purpose of science and technology teaching in general science education up to secondary stage is to familiarize the learner with various dimensions of scientific and technological literacy. These would include- understanding the nature of science; ability to properly apply appropriate science concepts and their technological applications; capacity to understand values that underlie science and technology, willingness to understand and appreciate the joint enterprise of science, technology and society, ability to develop rich and satisfied views of the universe and to continue science and technology education throughout life, and development of certain manipulative skills which are required in day-to-day life situations. In addition, to support and to develop these skills within and outside the laboratories it would be imperative to make use of tools of information technology such as computers and multimedia packages."

National Curriculum Framework for School Education (2005) has suggested that content, process and language of science teaching must commensurate with learners' age-range and cognitive reach. Science teaching should engage the learner in acquiring methods and processes that will nurture their curiosity and creativity particularly in relation to the environment. Science education should be placed in the wider context of children's environment to equip them with requisite knowledge and skills to enter the world of work.

It is clear from the above presentation that there has been change in the outlook for science education. Starting from inclusion of science as a subject, considering it as a discipline of mind, introducing scientific method for inquiry, promoting science laboratories, relating science with society and daily life, focus on scientific temper, developing information technology culture, relating science with child's age range and focusing more on science processes etc indicate a paradigm shift in science instruction and teaching learning process. Efforts were made to develop science education by modifying the curriculum school level time and again, introducing new methods of teaching, evaluation and giving emphasis on practical knowledge of science. There has been a paradigm shift in the understanding of science teaching

from rote memorization and transaction of knowledge to creating a new knowledge and developing critical thinking in the students.

1.4.1 Objective of science teaching at secondary level

Various policy documents have reflected on objectives of science teaching at various levels. Having reviewed above all, major objectives of science teaching are listed below:

- To provide students with scientific knowledge and skills to solve problems of daily life.
- To develop skills of observation through the study of natural environment around the students.
- To develop interest and curiosity about the natural phenomenon, environment and science related activities.
- To develop the ability to think logically.
- To develop the ability for using scientific method of work so as to improve quality of life.
- To help students to develop certain vocational productive skills so that the school learners can keep themselves gainfully occupied by self-employment or such other avenues.
- To develop in learner a system of values related to their personal and cultural life.
- To train students in scientific inquiry of any phenomenon.
- To develop scientific skills such as Experimentation, Handling the apparatus, Observation and Deriving conclusion etc.
- To develop science process skills which form part of attitude for developing a scientific temper.
- To develop appreciation for scientific phenomenon and work of scientist.
- To link science education to productivity.
- To develop scientific attitude, which equip students to continue science and technology education throughout life.

Above mentioned objectives provide guidelines for designing learning experiences in secondary science classrooms. Science teaching at secondary level has ample scope for providing variety of learning experience to the learner to achieve above mentioned objectives. It has scope of using various methods of teaching like demonstrations, historical, heuristic, problem solving, role-playing, group discussions along with lectures. In order to develop scientific attitude in the student and to inculcate aesthetic sense and exposing them to various setting such as field visit, science exhibitions, science museums, and science fairs needs to be included in science teaching.

1.4.2 Status of Science Teaching in India

The selection of method of teaching any subject is largely based on the objectives of teaching the subject, nature of the topic, level of learners and availability of resources. In a given set up, then, the selection of method of teaching depends on the nature of

the topic to be taught. All the methods are equally good if used effectively. The lecture method is the one, most commonly employed in the science classes, and even where lectures are followed by so called practical work, they do not develop a proper grasp of the subject matter or the necessary skill required for analyzing and solving problems on the basis of scientific principles and data, or the right attitude towards the process or spirit of scientific inquiry. Many policy and researchers in the area of science education reflected above observations, in general. Following discussion includes some of the findings confirming the above observations.

The report of the Education Commission (1964-66) stated that, in an average school; today instruction still conforms to a mechanical routine, and continues to be dominated by the old besetting evil of verbalism and therefore remains as dull and uninspiring as before." The report further remarks that "even where laboratory work is employed in science teaching, the approach is largely confirmatory and not investigatory so as to equip students in the techniques of acquiring knowledge by them selves." Rathore (1998) found that as far as the teaching methods were concerned, lecture method was used by majority of science teachers of secondary schools, and similarly Umashree (1999) found that majority of the teachers in science classrooms at secondary level follow lecture method (96%). Rathore (1999) reported that majority of teachers in uttarbuniyadi schools of Gujarat agreed that adequate training for instructors in content and pedagogy was quite helpful in improving the level of learning of the children.

Malhotra (2006) found that teachers often provide lectures and students mostly observe the teacher and their participation in classroom is very less. According to Khare (2009) majority of the teachers use lecture, demonstration, assignment and project method of teaching but few of them were not confident in doing demonstrations in classrooms. The laboratory methods and Heuristic method are rarely used. Secondary schools do not have separate science laboratory for secondary students. Neither separate periods for the practical nor are they evaluated on practical. These practices are of the key factors for constant decrease in the number of students opting for science stream at higher secondary and gradually at pure science in higher education. Even if they opt for science stream very few join for research in their respective field due to lack of interest in the field.

Krishnan (2002) while summarizing the proceedings of the national seminar on science education remarked about the state of science, that there was a clear gap

between what was achievable and what had been achieved. Few problems in achieving the achievable were highlighted: Reduced input of students to science, poor quality science teachers and lack of scientific man power to administer scientific enterprises in the country. Seminar conducted for reviewing and revitalizing the system of science education in India has pointed out the following suggestion for improving the quality of teachers and teaching science.

- Introducing content based curriculum changes.
- Change in the methods of teaching and making it more inquiry based, raising curiosity, conveying the excitement of science and understanding and exploring nature through experiments. Quantum of practical work, field work must be substantially increased. To aid learning by inquiry more exploratory methods must be incorporated into the curriculum.
- Need for a national model for science education.
- Increase the role of science journals, popular science magazines and comic strip
- Identification of strategies both local/region specific and for a country as a whole.
- Changing the do not touch and do not ask mindset.
- More science parks for learning science outdoors.
- Activities must be designed in full harmony with the child environment and from his environment more detailed concepts of scientific truth must be got and understood. This would sensitize the child to its environment and help to solve niggling problems at a later stage but makes the whole exercise of learning all the more interesting and invigorating.
- School teacher training programmes be increased all over the country and they should be given an opportunity to understand more recent developments taking place in their subject discipline. This would help them to imbibe the same excitement in their students and raise the level of teaching.

The first national science survey commissioned by Indian National Science Academy (INSA, 2005) and conducted by the National Council of Applied Economic Research (NCAER) intended to find out the status of science education all over India. The data were collected from 3, 46,000 people in rural and urban areas from different age group. Few of the results are as follows:

- Sixty percent of science post graduate students are unemployed.

- About one third of students said that they were not motivated enough to continue studying science after leaving school.
- Indian students lack in application level and focused group discussion session compare to knowledge and understanding level of questions.
- There is a need to strengthen the quality of science teachers, their teaching methods, and the educational infrastructures.

It a nutshell, science teaching in India has a scope for modification as it experiences shortcoming mentioned in the findings of various researches above. For that suggestions given by Krishnan (2002) can be incorporated. Attempts have been made locally as well as globally to improve training of science teachers so as to improve the quality of teachers and teaching. International science teaching standards have torched out the movement globally.

1.4.3 National Science Teaching Standards (United States of America)

Science teaching is a complex activity that lies at the heart of vision of science education presented in the National Science Education Standard for K12 schools. According to NSES, teachers must have theoretical and practical knowledge and abilities about science, learning, and science teaching.

- A challenge to teachers of science is to balance and integrate immediate needs with the intentions of the year long framework of goals.
- Inquiry into authentic questions generated from student experiences is the central strategy for teaching science.
- At all stages of inquiry, teachers guide, focus, challenge, and encourage student learning
- Teachers who are enthusiastic, interested, and who speak of the power and beauty of scientific understanding instill in their students some of those same attitudes
- Skilled teachers guide students to understand the purposes for their own learning and to formulate self-assessment strategies.
- Effective science teaching depends on the availability and organization of materials, equipment, media, and technology.
- The school science program must extend beyond the walls of the school to the resources of the community.
- Effective teachers design many of the activities for learning science to require group work, not simply as an exercise, but as essential to the inquiry.

- Although individual teachers continually make adaptations in their classrooms, the school itself must have a coherent program of science study for students.

Above Science Education standards are designed keeping in mind envisaged changes in the system. Following changes are envisaged in the system of science education while training the teachers.

Table1.1: Comparison between traditional school practices and proposed process based school practices

Traditional outlook	Envisaged changes
Treating all students alike and responding to the group as a whole	Understanding and responding to individual student's interests, strengths, experiences, and needs
Rigidly following curriculum	Selecting and adapting curriculum
Focusing on student acquisition of information	Focusing on student understanding and use of scientific knowledge, ideas, and inquiry processes
Presenting scientific knowledge through lecture, text, and demonstration	Guiding students in active and extended scientific inquiry
Asking for recitation of acquired knowledge	Providing opportunities for scientific discussion and debate among student
Testing students for factual information at the end of the unit or chapter	Continuously assessing student understanding
Maintaining responsibility and authority	Sharing responsibility for learning with students
Supporting competition	Supporting a classroom community with cooperation, shared responsibility and respect
Working alone	Working with other teachers to enhance the science program

From the above it is clear that a movement for enhancing the quality of science teachers has already started at international level. The teaching standards of USA for K 12 schools are equally important ad applicable to any science teacher in the world. There is a shift in the teaching methodologies, learning situations, way of assessments and evaluations. For quality science education quality science teachers are required to be prepared for the changing scenario. The hallmark of good quality teacher is thorough theoretical knowledge and practical abilities. Teacher preparation and orientation becomes very important factor to ensure quality of teachers. The system of teacher education is very crucial because it provides a professional training to the prospective and in-service teachers.

1.5.1 Teacher Education in India

Teacher education is the professional preparation in pedagogy, of those who want to enter the profession of teaching. This may be traditional or closed type with objectivist orientation, focuses on the product of learning and the progressive or open type with an orientation of subjectivity of the pupils focusing on the process of learning. Teacher education often limited to teacher training is strongly dependent on the level of economic development and the social context. It is deeply influenced by the local culture and history. The teacher education curricula are based on the national development, information about the agencies undertaking educational programmes, and activities which assist teachers in developing clear understanding of national educational goals. India has undergone various social and developmental transformations and subsequently school education and educational policies have been shifting their targets to meet the societal demands. Teacher training; in service and pre-service has also undergone new orientations and changes as per the needs of schools and society. Teacher education programmes have existed in the country for over a century. In the 1850's teacher training existed as an undifferentiated course of study meant for school teachers. Later on the recommendation of Indian education commission (1884), the teacher training programmes were made more differentiated and for graduates the course was designed to be of shorter duration. During the twentieth century, greater differentiation was sought and practices with respect to the stages at which teachers were expected to teach. Alongside, different training modes were introduced such as regular campus cum practicing school experience, correspondence cum content programmes and distance learning programmes.

Despite such diversification the basic features of these programmes as well as the theoretical premises have not altered significantly. Although the newer concerns, surfacing from time to time have been taken cognizance of, these have not influenced in any major way the main stream of system of teacher education.

In 1950 first conference of teacher education colleges in India was held at Baroda to exchange ideas on their programmes and functions and follow up meet was held at Mysore in 1951. It aimed at revising the curriculum of teacher education at various levels. In 1955 extension centers were established in every training college to organize seminars, workshops. Four Regional Institutes of Education (RIEs) started at Bhopal, Mysore, Bhubaneshwer and Ajmer for improving the quality of teacher education programme. Kurukshetra university also experimented by starting a four

year integrated course after higher secondary, but it was later stopped as it was not successful. A Centre of Advanced Study in Education (CASE) was established at the Maharaja Sayajirao University of Baroda, Vadodara. Thus, in fifties there was increase in teacher education programmes.

It attained quantitative expansion in the country but encounter criticism that it failed in rationalizing the need and supply of teachers at various levels. Some suggestive measures were provided and State Institutions of Education (SIEs) were established thereafter to review the quality at state level. A quick glance through surveys of educational research in India conducted periodically over the years 1974-2000 substantiates the point that teacher education programmes have remained unchanged in terms of their substance, experiences offered and modalities adopted.

The professional preparation of teachers has been recognized to be crucial for the qualitative improvement of education since the 1960s (Education Commission, 1964-66), but very few concrete steps have been taken to operationalise this. The commission, in particular notes the need of teacher education to be "brought into the mainstream of the academic life of the universities on the one hand and of school life and educational development on the other." The commission recommended the introduction of integrated courses of general and professional education in universities with greater scope for self study and discussion and a comprehensive programme for internship.

Chattopadhyay Committee Report (1983-85) of the national commission on teachers envisaged the new teachers as one who communicates to the pupils the importance of and the feeling for national integrity and unity; the need for a scientific attitude; commitment to excellence in standards of work and action and concern for society. The commission observed that "what obtains in the majority of our teaching collages and training institution is woefully inadequate. If teacher education is to be made relevant to the roles and responsibilities of the new teacher, length of training for a secondary teacher should be five years following the completion of class XII."

The National Policy of Education (NPE, 1986 and POA, 1992) recognized that "teachers should have freedom to innovate, to devise appropriate methods of communication and activities relevant to the needs of and capabilities of and concerns of the community"

Report of National Curriculum of Teacher Education: A frame work (1988) has provided broad direction in which desired changes can be brought about in the content

and process of pre-service education at elementary, secondary and preschool stages. It has emphasized on addressing the local specific needs and motivating teachers for research, experimentation and innovations.

The Yashpal Committee Report (1993) on learning without burden noted that main cause of unsatisfactory learning at school level is the inadequacy of teacher preparation programmes. Committee reported that "the content of the programmes should be restructured to ensure its relevance to the changing needs of school education. The emphasis in these programmes should be on enabling the trainees to acquire the ability for self learning and independent thinking." The reports of Acharya Ramamurthy (1990) and the National Advisory committee on Learning without Burden (1993) have drawn attention to the need for qualitative reforms of teacher education and suggested various measures.

In a nutshell, the above recommendation along with the reports for teacher education depict that within due course of time teacher education has undergone change in itself. Various reforms have been suggested but it noticed slow changes compare to the changes in the society in general and school in particular. The National Curriculum Framework for Teacher Education (NCFTE, 2006) provided guidelines for meeting the following paradigm changes in the school and teacher education level for teaching methods.

Table 1.2: Changing emphasis from tradition to prospective methodology of teaching in schools

From	To
Teacher centric, stable designs	Learner centric, flexible processes
Teacher directions and decisions	Learner autonomy
Teacher guidance and monitoring	Facilitation of learning
Learning in group	Cooperative learning
Learner receptivity	Learner participation in learning
Knowledge as "given" fixed	Knowledge evolves
Linear exposure	Multiple exposures
Common learning tasks	Individualized learning routes
Disciplinary focus	Multidisciplinary, educational focus

To realize the above changes in the schools, teacher education institutes have to bring changes as suggested by National Focus Group for curriculum reforms in India.

Tables 1.1 and1.2 show the shift in the focus of school pedagogical practices and teachers role in meeting the envisaged changes. Learner and learning are in the centre of any school activity and participation of learners is given more emphasis. Hence,

way of teaching, interacting and evaluation system of teacher preparation stages experienced a state of flux. Preparing competent, committed, responsible, techno-savvy teachers becomes the responsibility of teacher education system. Constructivist approach and its methodologies are the expected ways to train the teachers at pre-service level. Participatory experiential learning and activity based teaching are the new methodologies suggested for constructivist classrooms.

At elementary level there have been many interventions for preparing teachers of primary and upper-primary for activity based teaching methodologies. Fourteen states have already introduced the activity based text books and teachers have been trained for the same. In the state of Gujarat, it is likely to be introduced during the academic year 2010-2011 on experimental bases. To continue this chain at secondary level, secondary teacher education should tune to the changes in the training of prospective teachers.

1.5.2 Secondary Pre-service Teacher Education in India

In the post independence period secondary teacher education has registered tremendous expansion. These include State Institutes of Education, Secondary Training Institutes and University Department of Education. According to Mangala (2001) Secondary teacher education aimed at developing teaching competencies and ability to teach at secondary level looking into the respective specialization and academic discipline. It intends to develop proficiency in,

- Pedagogical analysis of content and planning of teaching learning
- Organizing learner centered activity based interactive teaching learning and utilizing different media resources.
- Facilitating active information processing and self appreciation
- Organizing learning experience under work experience education.

Sharma (1999) quoted that "By and large, training institutions for secondary teachers have remained isolated from the main stream of the academic life of the university, as well as from the daily problems of the schools. Members of the staff in all such institutions are by and large inadequately prepared for the job. The quality of training institutions remains, with a few expectations, either mediocre or poor. Competent staff is not attached, vitality and reality are lacking in the curriculum and programme of work which continue to be traditional, and rigid techniques are followed in practice teaching, with a disregard for present day needs and objectives" further talking about the methodologies of teaching, Sharma noted that, "Teacher educators in these

institutions by and large have allegiance to the traditional method of instruction like, lectures and dictation of notes. Their acquaintance with modern classroom communication devices is inadequate. In many classes lectures are dull, monotonous and uninspiring. As a consequence of this our student-teachers can only talk about the methods but can not use them with facility and care. There is absolutely no manifest or learnt concern on the part of teacher educators to achieve in a planned and systematic way the awareness and control over the instructional technology."

In short, teacher educators should make their methodologies of teaching potent enough to meet the present day needs. In the cases where the teacher educators are engaged in new pedagogical practices and innovations but researches or systematic records for that has not been maintained and hence these innovations and practices remained unnoticed. Mohpatra (2000) recommended that "teacher education institutes should be considered as living laboratories for research. Most researches should be conducted in real situations instead of studying the perceptions of teacher trainees, various learning situations are to be created and studied in natural settings."

Sharma (1999), Mohpatra (2000) and Mangla (2001) portray a gloomy picture about the teacher education at secondary level. Though time and again modifications in the curriculum framework for teacher education have been made, its impact is not seen widely. Few scattered efforts have been made to vitalize the teacher education programme in India to meet the present societal demands. Various innovative programmes have been introduced in the various universities/institutions or collages few of them which are of prime importance are mentioned in brief in proceeding section

1.5.3 Innovative Programmes for Secondary Teacher Education

Teacher education in India has noticed the growth in terms of increase in number of institutions but quality really remained unchecked. Following are the few of the programmes carried out to ensure the quality in teacher education. The major criticism teacher education encounters is the short span of training i.e. one academic year.

The four year integrated programme was introduced during the 1960s in NCERT's four Regional Colleges of Education in India. This programme was designed to prepare secondary school teachers in the Sciences and Humanities. The curriculum was initially designed to develop subject-based competency of the level of graduation along with professional competencies related to methodology of teaching. A

composite degree of B.Sc. B.Ed. was awarded on the successful completion of the course which was modified as B.Sc. for three years to enable students to join postgraduate programmes of study in various science disciplines led to the exodus of several students at the end of three years. At present composite degree at the end of four year the B.Sc. B.Ed. degree is awarded maintaining minimum entry requirement as senior secondary with science discipline (i.e., 12 years of schooling).The content of this integrated programme includes courses on subject knowledge (60%), professional education (20%) and general education (20%).

The Vedchichi programme of Teacher Education started in 1968 at Gandhi Vidyapeeth, Vedchichi in the Surat district of Gujarat a programme of one-year duration and admits 40-50 students each year which is Based on Gandhian philosophy, student life on the campus is based on principles of self-help and self-reliance. Students engage in cooking, cleaning utensils, washing clothes and in the maintenance of the entire campus as part of their learning activities to be self-reliant. Subjects are not taught as independent disciplines, but are woven into specifically designed activities or projects of 5 to 15 days duration including the local issues related to the rural areas. The main features of this programme are: learning through participation in activities; self-directed learning followed by group work and group discussion; independent analysis of a problem by student teachers and the practice of self-motivated learning based on experiences. It focused completely on participative process oriented Teacher Education programme in Gandhi Vidyapeeth at Vedchihi.

Hosangabad Science Teaching programme (HSTP) was an effort for providing the training of teachers for science experiments in the classrooms; firsthand experience of the skills and difficulties every experiment involved; and engaging them in discussions with their peers on the outcome of the experiments. This residential training involved discussions on various topics of science, laghuprashna and scientiiific investigation in the early morning followed by group work, using the science kit and discussion on the process of experiment. There were also evening lectures on general scientific matters. These were not directly related to the curriculum but more in the nature of enrichment material intended to arouse interest in scientific matters. This was an effort to provide exposure to the teachers for activity based teaching learning at elementary level.

An attempt was made at the Faculty of Education, Banasthali Vidyapith, during the year 1997-98 to create a differently designed TEP. The main aim was to explore the

possibility of evolving such a flexible programme within the available resource-time frame and of finding out the extent to which the experience becomes 'participative'.

The Programme which was named by the students as "Anweshana" and approved by the NCTE as B.Ed. (enriched), essentially comprises the following: Initiation involves making decisions as to how to go about independently; gaming, ice breaking; Sensitization comprises several inputs which lead to perceiving ones' own strengths and weaknesses, acceptance of others, significance of teacher roles and their demands and field conditions. Such sessions are more frequent in initial phase. Problem Practice theory model was implemented and practical exposure was more emphasized. The modes of interaction were both collectively and sometimes individually. The teacher educators were there to support, supplement, participate in the group processes and facilitate group's functioning. Appraisal and feedback comprise several kinds of appraisal acts in the form of self appraisal, peer appraisal, teacher feedback and also formal testing, as and when felt necessary. The university examination is held at the end of the year,

Gandhi Shikshan Bhawan, an affiliated College of Education of Bombay University offers an integrated B.Ed. degree programme for secondary school teachers since 2000. It provides first hand experiences of a slum community. The aim is to make student teachers aware of the socio-economic, cultural traditions of the poor and backward and its impact on the education and development of children. Teachers are educated to develop the conviction and the professional skills to help children come out of such adverse conditions. Such an approach has now become a part of the B.Ed. degree programmes of all the Colleges of Education of Bombay University. Department of education of Jamia Millia has proposed to incorporate the social context elements into teachers training programme. Navrachana University, Vadodara has introduced four years integrated B.sc.B.Ed. Programme recently in 2009 with a view to create competent science teachers.

All the above are the attempts made to improve the quality of teaching and teachers at secondary level. The focus of the programmes was to incorporate the cooperative, participative and active learning strategies to train teachers in order to provide them hands on experience about learner centered methodologies. These programmes are specific to particular institutions but have scope of dissemination to other institutions. Hausangabad science teaching programmes and Vedchhi experiment popularly known as 'avishika' (Adyeta Kendri Vigyan Shikshan Karyakram) were the two major

innovative programmes to train the science teachers but could not succeeded. Teacher education programmes with more than one year duration could not registered a scuess story. These programmes fail to attract even minimum required students and hence either stopped or striving for existence. The activities and strategies involved in these programmes can be utilized with certain modification in one year regular B.Ed. programme. A one year B.Ed. programme incorporating participatory learning, hands on experiences, collective thinking and active involvement of student teachers can be developed to prepare the teachers who can meet present day needs.

Report of National Curriculum Frame work for Teacher Education (2009) provides a set of guidelines for preparing a humane teacher and identifies the characteristics of a teacher as follows.

Society needs teachers who can:

- Care for children and love to be with them, understand children within social, cultural and political contexts develop sensitivity to their needs and problems, and treat all children equally.
- Perceive children not as passive receivers of knowledge, augment their natural propensity to construct meaning, discourage rote learning, make learning a joyful, participatory and meaningful activity.
- Critically examine curriculum and textbooks, contextualize curriculum to suit local needs.
- Do not treat knowledge as given; embedded in the curriculum and accepted without question.
- Organize learner cantered, activity based, participatory learning experiences; play projects, discussion, dialogue, observation, visits and learn to reflect on their own practice.
- Integrate academic learning with social and personal realities of learners, responding to diversities in the classroom.
- Promotes value of peace, democratic way of life, equality, justice, liberty, fraternity, secularism and zeal for social reconstruction.

Science being one of the compulsory subjects with due importance and with its very nature provides ample opportunity to incorporate various learning situations for student teachers. This auger for knowing the status of teaching of science at B.Ed level.

1. 5. 4 Status of Teaching of Science at B.Ed. Level

Science is taught at pre-service level as one of the specialized methods to student teachers, who are master or bachelor degree holders in science. There are mainly three types of institutions in our country with respect to subject matter of science and technology is concerned.

1. Teach the content of secondary science as one of the subjects and evaluate the student teachers.
2. Do not teach the content of science but evaluate on the content of science.
3. Teach only methodology of science teaching.

Mostly the focus is on the third, i.e. methodology of science teaching. How ever, science method teaching at this level is suffering with certain short comings, as observed by the eminent educationists. Some of them, which are directly related to the teaching learning process, are listed below:

- The knowledge about the various teaching methods and approaches is given to student teachers by using only teacher centered methods. In this way there is emphasis on aspects like, Why to use this method? When to use this method? But not much emphasis is on How to teach a particular content using this method? Vaidya (2003)
- Lack of necessary facilities like well established science laboratory at the teacher training institution is primarily responsible for lack of clarity in conducting the experiments. Desai (1986)
- There is a lack of scope for experiential learning to consolidate knowledge on part of student teacher. Umashree (1999)

Such a scenario at pre service level merits a need for changing the methodologies, for necessary improvement. The survey of INSA (2005) reflected that Indians are lacking in application levels of questions compared to the foreign students, whereas they are doing well in knowledge levels of questions. In the era of globalization provisioning of competent citizens stems from the preparation of efficient teachers.

Following are the guidelines provided by National Focus Group on Teacher Education for Curriculum Reform (2006).

1. The learning inputs in such a Teacher Education Programme (TEP) will be predominantly learner oriented as it would provide for variety in learning exposures, accommodate differential learning, and encourage divergence, reflection and insightful treatment of a learning situation.

2. The TEP has to include teacher competencies beyond the usual oral, verbal ones which are required in the participative learning process, some of them are
   - ❑ Identifying sources of information needed by students to generate learning activities and make them available to learner with differential needs.
   - ❑ Variety of activities for different learners.
   - ❑ Reading material for the stages of learners.
   - ❑ Group and individual problem solving targets.
   - ❑ Use of study and hands on experience.
   - ❑ Respond to learner in order to lead them on without providing answer or solutions.
   - ❑ Discern learner's logic in the way he/she goes about discovering and support it.
   - ❑ Accept divergent responses without judging their "correctness'.
3. The competencies mentioned cannot be developed through imaginary lecture. Therefore during TEP it is visualized that through the use of multiple exposures ample opportunities could be provided to student teachers to observe, discern, discuss, tryout, understand and learn to make decision on the "what and how" of creating learning situations. For this, some very positive, feasible situations will have to be created through virtual imaging, exemplar situations from the field or the descriptions along with adequate discussions on the conceptual explanations for these as well as reference work and of course actual practice.

It has emphasized "teaching learning should be in central in education. Articulation for this can be derived from the conceptual framework for school education." It also provided certain significant points for its operationalization. Focus here is to develop teachers who are capable, affectionate as well as competent to cater to the needs of the learners. If one considers the objectives provided in the 1.4.1 and changes needed in science teaching and compare it with guidelines provided above, preparation of student teachers in science subject has a scope of incorporating it to the best due to its very nature. Science teaching has ample scope of incorporating various learning situations to enhance their level of motivation, interest and level of science learning. Science teachers can be prepared based on the above guideline to enhance their teaching quality. Active Learning Methodologies suggested in the NCF (2005) and supported by NCFTE (2009) can be one the ways to enhance the quality of teachers.

In order to transect the ALM in classroom learning experiences should be based on Activities group as well as individual.

1.6.1 Activity Based Learning

Activity is the state or quality of being active; nimble; agile; vigorous action or operation; energy; active force; as, an increasing variety of human activities. Activity Based Learning involves multiple sences or modes to learning. John Dewey Emphasized the learning through activity and child centered instruction which was advocated during the eighteenth and nineteenth century by Pestalozzi and Froebel. The most representative feature of Dewey's philosophy of education was his recommendation of the project method of learning described by various followers as a purposive, problem solving activity carried on in its natural setting" (Smith, 1979, p. 187). Activity based learning can be differentiated from other methods by the central criterion that students interact with materials to make observations, where in the approach involves more than a mere activity. The assumption is that direct experiences with natural phenomena will provoke curiosity and thinking, According to Sandra Rief, "students remember "10% of what they read, 20% of what they hear, 30% of what they see, 50% of what they see and hear, 70% of what they say, 90% of what they say and do". There are a variety of ideas about what constitutes activity-based learning. Educational Research and Information Centre (ERIC) clearinghouse for science and mathematics research compiled views from teachers, curriculum developers, and other writers to arrive at a general notion of activity-based learning in science, which encompasses its use in school classrooms, museums, and other learning environments. From the collected responses and writings, ERIC has drawn a conclusion that, Activity-Based Learning (ABL) in science to be any educational experience that actively involves people in manipulating objects or situations to gain knowledge or understanding. ABL includes cooperative learning, small group learning, active learning, hands on learning, experiential learning, collaborative learning etc. It involves various methods like discussion, problem solving, play way, brainstorming, fieldtrip, demonstrations, experimentation and heuristic. These methods are the means to bring the constructivist pedagogy in the classroom transactions. Understanding any thing is to put one's hands on it and hence, providing activity based learning to the students, calls for teachers pre-preparation for it.

1.6.2 Activity Based Science Teaching

There are a plethora of benefits that teachers and curriculum developers adduce activity based teaching to justify this approach in science. Benefits for students are believed to include increased learning; increased motivation to learn; increased enjoyment of learning; increased skill proficiency, including communication skills; increased independent thinking and decision making based on direct evidence and experiences; and increased perception and creativity. Researches carried out in this area support many of these claims by providing evidence that the learning of various skills, science content, and mathematics are enhanced through ABST. Students in activity-based programs have exhibited increased in creativity, positive attitudes toward science, logic development, communication skills, and reading readiness. These benefits seem more than sufficient justification for promoting activity-based teaching. Piaget (1969) has given some suggestions that, teachers while teaching science can ensure science learning in students,

- By building quality in science lessons
- By using varied methods and approaches to teaching.
- By providing significant and worthwhile experience.
- By providing variety of activities such as

  Oral activities : Inviting questions and receiving answers, narrating experiences, making comments, participating in general class discussions, etc.

  Written experiences: Copying relevant material from the books and journals seeking information, making summaries, writing short review of the books taking notes drawing diagrams, etc.

  Visual activities : Reading and interpreting charts, diagrams and graphs, studying apparatus, specimen and pictures, observing films and film strips, gathering information from bulletin boards, etc.

  Practical activities : Setting up experiments both in the laboratory and at the science fairs and exhibitions, constructing and improvising apparatuses, preparation of charts and diagrams in groups or alone, going to the fields and noting the observations, etc.
- By effective questioning to enable students to think the possible solution, to participate actively in the teaching learning process, to arouse interest, stimulate curiosity and to develop in them the functional understanding.

Revealing the facts regarding Indian Science Education, in the minutes of the Seminar on Science Education Programme: Trends and Future Initiatives, organized at New Delhi by Indian National Science Academy (INSA) in May 2002 underlines that "*'do-not-touch mindset'* that is taught in the present system ought to change. Students must be encouraged to ask questions, understand the history of science, find how science is so entwined in their daily lives, feel the excitement for science and understand that there remains a lot to be still done." Jain (2002), Director of INSA has suggested that "School teacher training programmes must be increased all over the country and teachers should be given an opportunity to understand more recent developments taking place in their subject disciplines. This would help them to imbibe the same excitement in their students and raise the level of teaching. "

If activities mentioned above are to be used while teaching science at secondary level teachers should be prepared for the same is required. Training of science teachers;

In service and pre service for Activity based teaching can provide them exposure for the same. Teachers by actually undergoing and experiencing various activities can be better prepared for dealing with science in the secondary school level.

1.6.3 Activity Based Science Teaching at B.Ed. level

The innovative practices carried out in various areas have paved the way to activity based teaching. It is said that personality of a child is getting shaped during the school years and classroom interaction plays vital role in that. Teachers' role is crucial in ensuring classroom interactions where by students are encouraged to participate and take maximum benefit of it. Teacher's personality, way of interacting and way of teaching, influence the students' development.

Thus, it is mandatory to provide proper kind of orientation to the teachers. In addition, nature of science provides more opportunities to explore the scope of using activity based approach. Therefore one it can be visualized that Science teachers are required to be exposed to teach science through activity. Shukla (2003) found that methods of teaching had significant effect on the achievement of the student teachers and those who were taught through video, discussion scored better in the achievement test compared to the traditional methods of teaching. All inputs are to be given to emphasize more of activities rather then providing theoretical knowledge of methodologies. The present study is an attempt in this direction to orient the students of the course "Teaching of science" at Bachelors of Education course at Department

of Education, Faculty of Education and Psychology, The Maharaja Sayajirao University of Baroda, Vadodara.

1.7.1 The Maharaja Sayajirao University of Baroda, Vadodara

The Maharaja Sayajirao University of Baroda (M.S. University of Baroda) is the first teaching, residential and unitary university of Western India. It is established in early 1949 and started functioning from April the same year. The Government of Baroda, visionary king of the state after whom it is named and its people had for a long time desired to have a separate University of their own. The main object of establishing the Maharaja Sayajirao University of Baroda was, to provide a distinct type of University a teaching and residential university which should have complete freedom in all academic matters and would be free to institute new branches of studies suited to the needs and aspirations of the region in particular and of the country in general.

In the year 2009 university has completed successful sixty years of its journey in higher education. Since the early days of its establishment, functions of the university are seen as imparting and disseminating knowledge, creation of knowledge and extension. In persuasion of these goals, from the existing colleges and institutions, faculties of Arts, Science, Commerce, Education and Psychology, Technology and Engineering and collage of Indian music, Dance and Drama as well as College for fine Arts were established and some new faculties like Home Science, Social Work, Medicine, Poly technique, law, management and Journalism & Communication were instituted. The university caters to the educational needs of more than 37,000 students through a variety of courses in different disciplines. For this purpose university has 13 faculties having total 82 Departments out of which 50 departments are in Sciences, Social Sciences and Humanities along with six colleges and recognized institutions. The UGC has recognized several departments as Centre for Advanced studies or as worthy of Special Assistance. {Source: Diary, the MSU of Baroda (2009).}

1.7.2 Faculty of Education and Psychology

The Faculty of Education & Psychology of the Maharaja Sayajirao University of Baroda has its origin from the Secondary Training College, Baroda. Mr. R. Littlehaile, the then Education Commissioner with the Government of India, made a survey of Education in the Baroda State in 1933. He found the paucity of Trained Teachers in Secondary Schools in the state. In his report he recommended for starting a Secondary Teachers Training College. Gaikwad accepted the proposal and established Secondary Teachers Training College, Baroda in 1935. It was affiliated to

the University of Bombay in the year 1938. This institution became the Faculty of Education & Psychology in the year 1949 as the constituent of the Maharaja Sayajirao University of Baroda with two departments Education and Psychology. The Practicing High School of the Secondary Teachers' Training College was also reorganized into the University Experimental School with all the Primary and Secondary classes for Practice Teaching and Experiments. In the year 1951, the Department of Educational Administration was set up. It was followed by the establishment of two more departments, viz., The Department of Extension Services in 1955 and the Department of General Education in 1957 which offered General Education courses to the students of different faculties of the University. The building in which the faculty is housed is one of the architectural treasures of the period designed by Sir W. Emerson in Indo-sacrenic style with dome in the centre.

1.7.3 Department of Education (CASE)

When the Maharaja Sayajirao University was established and the Faculty of Education and Psychology was started in 1949, the existing Secondary Teachers' Training College of Baroda was continued as the Department of Education. The college has a glorious record. It continues to provide leadership to the entire field of Teacher Education in the country. In recognition of its excellent contributions in the area of teaching, research and extension, the University Grants Commission raised it to the status of the Centre for Advanced Study in the discipline of Education (CASE) in 1963-1964 and it also enjoys the states of Institute of Advanced study in Education since 2004. It offers the Bachelors in Education, Masters in Education, Ph.D. in Education And one self finance course namely Post Graduate Diploma in Guidance and Counseling. Research and extension has been the unique culture in the department. Many of the research work carried out in the department have been institutionalized in instructional processes; microteaching experiments, Programmed Learning Material for the Educational Evaluation and the inclusion of course Information and communication Technology as a compulsory course at B.Ed. level.

1.7.4 Bachelors of Education programme at CASE

The Bachelors of Education is a one year fulltime Degree Course for training the perspective teachers of secondary and higher education. The programme includes eight compulsory courses, fifteen special fields and fourteen method courses, practical work and practice teaching. Its courses like teaching of physics, teaching of chemistry, teaching of biology and teaching of accounts has been rarely offered in any

teacher education institution. It does not provide any direct teaching to the subject specific content in the method courses neither the students are evaluated on the basic of it. Pedagogical training is provided to them with the following objectives.

1.7.4.1 Objectives of Bachelors of Education Programme

The Bachelor of Education Degree course aims at enabling the student teachers:

- To develop a critical awareness regarding the realities of Indian life.
- To develop such capabilities as may be necessary for the realization of national values and goals as stated in the Constitution of India.
- To develop an understanding of the objectives of school education in the Indian context and awareness of the role of the school in achieving the goals of building up democratic, secular and socialist society.
- To develop an understanding of the psychology of students.
- To cultivate rational thinking and scientific temper.
- To develop competencies and skills needed for becoming effective teachers.
- To develop an understanding of the principles of pedagogy, curriculum development, its transaction and evaluation.
- To develop the knowledge of the subject, clarify its objectives, evolve a suitable methodology of instruction and sharpen the communication skills.
- To develop the managerial and organizational skills required in the contemporary Indian educational contexts.
- To become aware of the environmental and ecological problems and to find out their suitable solutions.

1.7.4.2 Admission criteria for the B.Ed.

A Candidate seeking admission to B.Ed. Programme must satisfy the following conditions:

- He/She must be graduate from the M. S. University of Baroda or from any other University recognized as equivalent for the purpose. He/She must have taken the Bachelor's Degree as a regular student in the 10 + 2 + 3 or 11 + 4 pattern.
- He/She must have taken the Bachelor's Degree at least with 50 percent marks in the aggregate or equivalent grade. If he/she is a graduate with less than 50 percent marks or with lower grade, he/she must have a master's degree in the relevant subject.
- If a candidate is a graduate, he/she shall have graduated with one of the secondary school subjects as a major subject and if he/she has a master's degree,

he/she shall have offered one of the higher secondary school subjects as a major subject. If a student has offered subjects such as Psychology, Commerce (B.Com.) at graduation level and Philosophy, Sociology, Political Science, Public Administration, Archaeology, Museology, Home Science, Persian, Urdu etc., at graduation as well as post-graduation levels, he/she is not considered to be eligible for admission to the B.Ed. Programme.

- The subjects offered by the student at the graduation and post-graduation levels will form the basis for selection of one/both method/methods at B.Ed. level. It may be noted that English, Hindi or any other language studied as the compulsory subject at graduation level will not be considered for this purpose.
- He/she must have offered English as one of the subjects at the higher Secondary/College or University level.
- A candidate admitted to the B.Ed. programme shall not do any other job/course during the same academic year.
- The total enrollment in B.Ed. course will not exceed 180 candidates for the academic year.

The course includes eight compulsory courses, fifteen special fields, fourteen method courses, practical work, practice teaching and internal and external viva details of which is appended in Annexure XVII.

1.7.5 The course 'Teaching of science'

At Department of Education, 'Teaching of science' is the course offered as one of the method courses to those who are graduates and/or post graduates in science discipline as per the admission criteria and B.Ed ordinance (Appended). On an average forty five students out of 180 opt for 'teaching of science' as one of their methods. Out of which ninety five percent of them are masters in science with various subjects' viz. mathematics, physics, chemistry, biology rest of them are bachelors in science with any of the above mentioned subjects. The course aims to develop competent science teachers for teaching the subject 'science and technology' at secondary level. Objectives of the course are as follows:

- To develop among the student teachers an understanding of science as a discipline.
- To enable the student teachers to understand the importance of teaching science in school.
- To make the student teachers aware of the alternatives in organizing the system of science instruction.

- To develop in them the necessary understanding and skills to organize, evaluate and improve the system of science education.

In order to achieve the above said objectives in an academic year spread over two semesters, the Course is divided in to eight units as follows. Detailed syllabus is appended in Annexure XII

Unit one	Nature of Science
Unit two	Objectives of teaching Science
Unit three	Content-cum-Methodology
Unit four	Models of Teaching Science
Unit five	Resources for Teaching Science
Unit six	Science Curriculum
Unit seven	Science Activities
Unit eight	Evaluation in Science

It is four credit course having two periodical tests in one semester each, two practical assignments one semester each and a comprehensive exam at the end of the year. Course content is revised time to time and last it was revised in the year 2008.

The course provides exposure to the students about science as a discipline of mind and methodologies of teaching the subject science and technology at secondary level so as to train the students for developing curiosity, interest for science and inquiry mind. This requires a rigorous instruction process and varied learning experience to be provided by teacher educators. As mentioned above the unique feature of the course is, it does not provide any direct teaching of content of the subject 'science and technology' to the student teachers and neither are they evaluated on the subject content of secondary level in the as part of their assessments.

The course structure has scope of implementation of expectations of NCF (2005) and NCFTE (2009) of preparing humane teachers by providing the student teachers various exposures mentioned by Vaidya (1969) and supported by NCERT (1986). In the guideline of curriculum transaction NCERT(1986) described that "Among the techniques of instruction which play an important role in the type of effective curriculum transaction involving activity based approach, the teacher has to be apt at: Planning of activities, Preparing the students for activities, Conducting and supervising activities and Conducting discussion for evaluating learning outcomes. These recommendations are not transformed in the teacher education institutions and researches in these directions are not recorded. NCFTE (2009) laid great emphasis on learner cantered, activity based, participatory learning experiences play, projects,

discussion, dialogue, observation, visits and reflections based training of the student teachers.

Researcher being involved as one of the three teaching faculties in this course since last six years has tried to include varied mode of transecting the content of the course and various activities are conducted. On the basis of the literature reviewed it has been thought of carry out a systematic research work on classroom teaching of the course by using various activities and studying its implications on student-teachers. Classroom teaching experiences and student teachers' feed backs have stimulated the process of conceptualization. Thus, looking into the time period available for investigation the intention here was to study the awareness created in student teachers throughout the academic year with the help of Activity Based Science Teaching programme (ABSTP).