1.1 Introduction

Education is the process by which an individual is encouraged and enabled to develop his or her full potential. It may also serve the purpose of equipping the individual with what is necessary to be a productive member of the society. Education endows people with the ability to put their potential to the maximum use. One can safely say that a human being has not realized his full potential till he is formally educated.

The importance of education stems from two factors. The first is that the training of a human mind is not complete without formal education. Education makes man a right thinker. It trains man on how to think and how to make decisions. The second reason for the importance of formal education is that only through the attainment of education i.e., literacy and numeracy, man is enabled to receive information from the external world; to acquaint him with past information and receive all necessary information regarding the present.

Generally, at a very early age, children learn to develop and use their mental, moral and physical powers, which they acquire through various types
of education. Education is commonly referred to as the process of learning and obtaining knowledge which usually starts at school. However, the process of education not only begins when a child first attends school, education begins at home. Knowledge is not only acquired from the teacher but also from parents, family members and even acquaintances. However, in almost all societies, attending school and receiving an education is extremely vital and necessary, if one wants to achieve success and improve one's quality of life.

1.2 Education in India

India is a country with an ancient civilization well known for its system of education. It had evolved a unique system of education called ‘Gurukula’, which meant teacher’s home, as the training of the student took place at the teacher’s home. Research shows that in the ancient days, sages and scholars imparted education orally. The system was developed for the study of the Vedic texts and was elitist, as only a small proportion of young men usually from the nobility could be educated through the system of gurukula. Most of the children probably learnt their trade from their fathers. When Buddhism spread in India, education became available to everyone and this led to the establishment of some world renowned educational institutions i.e., Nalanda, Vikrmshila, Takshila, etc.

With foreign invasions and changes in the political structure, the
indigenous and traditional educational system also changed. It was in the 11th century that the Muslims established elementary and secondary schools. This led to the forming of a few more universities. Later, when the British arrived in India, systematic and formal educational institutions came into being with the help of the European Christian Missionaries. Since then, Western education has made steady advance in the country. Now there are hundreds of universities and thousands of colleges in every discipline. India has positioned itself comfortably as a country that provides quality education to its people in specific and to the world in general.

1.3 School Education

School as an institution imparts knowledge and teaches children to learn a variety of basic skills. It gives them a background in different subjects. The reading habit inculcated in the children at a very young age, enables them to pursue reading all through their lives. Reading, writing, and simple arithmetic are very important skills for any individual in today’s world.

School education gives students the experience and the confidence, they require. Attending school provides students opportunities to express themselves and to learn about other people and their ideas. The knowledge obtained in school gives individuals the confidence that is needed to face the society.

In recent times, the school education has emerged as an important
segment of the total educational system, expected to contribute significantly to the individual as well as the national development process. An important feature of educational development in India has been the sustained effort to evolve a national system of education.

1.4 The Objectives of Educational System in India and their Rationale

In the Indian way of thinking, a human being is a positive asset and a precious national resource. In the national perception, education is essential for all. Education is fundamental to our all-round development, both material and spiritual. The objectives of education in India are mainly based on Indian philosophy and are also drawn in the backdrop of the secular, democratic and federal structure of the Indian politics as set down by the Constitution of India (NCF, 2005).

The National Council of Educational Research and Training (NCERT) is an apex resource organization set up by the Government of India, to assist and advise the Central and State Governments on academic matters related to school education. Developmental activities in school education constitute an important function of the NCERT. The major developmental activities include development and renewal of curricula and instructional materials for various levels of school education and making them relevant to the changing needs of children and society.
1.5 Education Commission (1964-66)

In 1964 the Central Government appointed a committee under the chairmanship of Dr. D. S. Kothari to frame a national policy which would give shape and direction to India’s school education system. The Kothari Commission Report on Education (1964-66), which is a critique of Indian education, is regarded as the most in-depth study of primary and secondary education in India for the past four decades.

The main features of the Commission’s report were as follows:

i. Introduction of work-experience which includes manual work, production experience, etc., and social service as integral part of general education at more or less all levels of education.

ii. Stress on moral education and inculcation of a sense of social responsibility.

iii. Vocationalization of secondary education.

iv. Strengthening of the centers of advanced study and setting up of major universities which would aim at achieving highest international standards.

v. Special emphasis on the training and quality of teachers for schools.

vi. Education on agriculture and research in agriculture and
allied sciences should be given high priority in the scheme of educational reconstruction.

vii. Development of quality or pace-setting institutions at all stages and in all sectors.

The Kothari Commission’s recommendation of a common school system (CSS) across the country was endorsed by the National Education Policies of 1986 and 1992. The National Policy on Education, modified in 1992, stressed the need for evolving a national system of education based on a common educational structure (10+2+3 years), a national curriculum framework and the minimum levels of learning for each stage of education.

1.6 Structure and Stages of School Education

A uniform structure of school education, the 10+2 system has been adopted by all the States and Union Territories (UT) of India, after a lot of research and suggestions of different national committees and commissions. However, within the States and the UTs, there remain variations.

The pre-primary stage of education helps in preparing children for school and constitutes an important element of early child care and education. In the next stage the children are just introduced to formal teaching with basic skills of the 3Rs’s are at a stage of development which requires a smooth transition from informal and non-formal environment to a formal one. Then they are prepared to understand the environment and
learn in a systematic way. The Secondary Education which serves as a bridge between primary and higher education is expected to prepare young students for higher education.

1.7 National Curriculum Framework (NCF)

National Policy on Education recommended a common and uniform core component in the school curriculum throughout the country. The policy also entrusted to the NCERT with responsibility of developing National Curriculum Framework and reviewing the framework at frequent intervals.

The aim of Indian education policy is to generate a curriculum that is inclusive of the rich inheritance of different traditions of knowledge, work and crafts. The development of self-esteem and ethics and the need to cultivate children’s creativity would receive primary importance. In the context of the quick changing and competitive global scenario, it’s imperative that we respect children’s native wisdom and imagination.

The major guiding principles of school education in India have been:

- Connecting knowledge to life outside the school
- Ensuring that learning is shifted away from rote methods
- Enriching the curriculum to provide for overall development of children rather than remaining textbook centric
- Making examination more flexible and integrated with classroom life
National Curriculum Framework (2005) is a means of evolving a national system of education capable of responding to India's diversity of geographical and cultural milieus. It also common core of values along with academic components. It is envisioned as a means of modernizing the system of education. The National System of Education is based on a national curricular framework for school education, which contains a common core along with other components that are flexible.

1.8 Scheme of Studies

The general objectives of school education are realized through the content and learning experiences related to different subject areas. The main curricular areas such as, Language, Mathematics, Science and Social Science (Social Studies) relevant for curricular planning have remained remarkably stable for a long time, despite major changes in social expectations and the academic study of different broad disciplines. In addition, Art, Work, Peace and Health and Physical Education have been classified as ‘extra-curricular’ to deserve special attention.

According to the NCF, languages provide a bank of memories and symbols inherited from one’s fellow speakers and created in own lifetime. They are also the medium through which most knowledge is constructed, and hence they are closely tied to the thoughts and identity of the individual. In fact, they are so closely bound with identity that to deny or wipe out a
child’s mother tongue(s) is to interfere with the sense of self. Effective understanding and use of language(s) enables the child to make connections between ideas, people and things, and to relate to the world around.

The teaching of mathematics enhances the child’s resources to think and reason to visualize and handle abstractions, to formulate and solve problems. This broad spectrum of aims can be covered by teaching relevant and important mathematics embedded in the child’s experience (NCF, 2005).

The teaching of science enables children to examine and analyze everyday experiences. Concerns and issues pertaining to the environment should be emphasized in every subject through a wide range of activities involving outdoor project work.

1.9 Science Education in India after Independence

After the independence of our country, Indian government appointed number of education commissions for the welfare of the education, especially science education.

1.9.1 University Education Commission (1948-49)

The University Education Commission (1948-49) made recommendations for improving laboratories, and libraries. It was narrow specialization in science and technology. The commission opined that the curriculum of general education should have relevance to the students
physical and social environment and have science, language and literature at various levels up to the end of the secondary stage.

1.9.2 Secondary Education Commission (1952-53)

The Secondary Education Commission 1952-53 recommended the teaching of general science as compulsory subject in the higher secondary schools. Science found a place in the diversified course too. The suggestion to retain general science as a core subject is a significant milestone in the history of science education in India.

1.9.3 National Council of Educational Research and Training (NCERT)

NCERT (1961) sponsored by the National Government at the centre has re-organized and re-planned the education of science in all areas and fields. This central organization has launched various schemes through its extension services for the improvement of scientific education at all levels and in all fields of human work. Some of its working schemes are as follows:

i. Various schemes have been launched to stimulate the urge for scientific education among school children.

ii. Establishment of science clubs is promoted to popularize scientific education among common people.

iii. Science fairs, seminars and symposiums are organized.
iv. Talented and gifted children in the field of science are selected through examinations and encouraged by the award of scholarships, stipends and appreciations in various ways.

v. On the advice and under the guidance of talented and learned member of UNESCO, the council has established a central science workshop for imparting effective instruction to science teachers in practical investigations, workshop methods together with techniques of work and instruction.

vi. A part time curriculum for teacher training has been organized at various important places in the country to prepare efficient science teachers for the effective teaching and productive guidance.

1.10 Background of Science Education

Students bring the legacy of their cultural backgrounds to their studies. They have all experienced science learning outside the classroom and can form and express their own views. This means that they have their own attitudes towards science education and attention must be paid to them.

There can be substantial discontinuities between what young people experience in their school science lessons and in the rest of their lives. Aikenhead (1989) has argued that school science expects young people to cross this border, which is more forbidding for some students than for others. Schreiner (2000) has explored the way in which student attitudes towards
science can be seen as expressions of their identity, while Reiss (2000) concluded that school science education can only succeed when students believe that the science they are being taught is of personal worth to themselves.

Unless school science explicitly engages with the enthusiasms and concerns of the many groupings that make up today’s students, it will lose their interest. Accordingly, it needs to grapple with how it can respond positively to the wide diversity of student concerns. It must think how to better address women, those who hold strong religious views, those who have little cultural capital, and those whose current or recent roots lie outside Western societies. All too little is known systematically about these issues.

A conundrum for science educators is that school students are being turned off school science lessons, yet the same students are often engaged by science outside the classroom. Science in science museums, hands-on centers, zoos and botanical gardens is often seen as exciting, challenging and uplifting. Newspapers and magazines offer rich sources of science information including debates about controversial current issues. Multi-channel television and the internet have spawned sources of high-quality and attractively packaged information about science and issues of relevance to young people. We are also living in a golden age of popular science book publishing, with a wealth of high-quality science books for children as well as
Students of school age spend about two-thirds of their waking lives outside formal schooling. Yet science educators tend to ignore the crucial influences that experiences outside school have on students’ beliefs, attitudes and motivation to learn. They often see these influences only as a source of misconceptions.

Out-of-classroom contexts can add to and improve the learning of science in several ways. They can promote the understanding and integration of science concepts. Falk and Dierking (2000) have reviewed studies that show that science museum visits can lead to improved understanding of such classic school science concepts as force and motion, an improvement measured by tests of knowledge before and after visits. They are also an opportunity to engage in science activities that would not be possible in the school laboratory either because of safety considerations or because they are too complex. Examples include launching rockets, performing ecological surveys, observing the night sky, and large scale experiments with combustion. How these activities contribute to students’ knowledge of the processes of science is still not clear. And they can provide access to rare material and to ‘big’ science. Science museums, botanical gardens, zoos and science industries provide opportunities for students to see yesterday’s and today’s science in use. Artifacts and collections, and the
stories associated with them, help teach about the ways in which scientific and technological knowledge has been generated and about the social enterprise in which those who engage in this work operate. Here too, the exact contribution to school science is unclear. Such activities also provide opportunities for science activities which are less constrained by school bells and lesson times. Work can be more extensive and there are more opportunities for students to take responsibility for themselves and others, to work in teams and to consider their effects on the environment.

But there is more to using out-of-school settings to enrich formal science education than taking students on a day trip. The resource has to be evaluated by the teacher in advance and the students must be prepared for the activity they are to undertake. The activity must be purposeful and produce a record, and the work must be followed up later in the classroom. Other important issues that must be addressed include health and safety risk assessments in all cases and in many instances, travel arrangements and staffing levels. The extra effort required to meet these conditions can be considerable and can discourage the use of these opportunities.

Although out-of-classroom contexts are valuable for learning in science, there is much about them that is under-researched. Further research is needed into the long-term impacts of out-of-classroom learning in science and attitudes to science; how the formal and informal learning sectors can complement one another to maximise their joint contribution to
students’ learning in science; how out-of-classroom contexts can engage with the full range of students of school age; how school grounds can be used to improve learning in all the sciences, not just ecology; and the particular worth of residential activities.

What students bring to the science classroom, whether from their cultural background or from out-of-school experience, is reflected in their inclination to form and express their own opinions. The notion of ‘student voice’ emphasises students as active participants in education. Its relevance for science education has been comprehensively reviewed by Jenkins (2005). He points out that the United Nation Convention on Children’s Rights requires that children be consulted on matters that directly concern them. A recent major Teaching and Learning Research Programme project, Consulting Pupils about Teaching and Learning, carried this perspective forward. Student’s views exhibit diversity, not least between genders, but have provided some indication of the kinds of subject matter which might increase enthusiasm for school science. Students also express definite views on teaching methods, with a dislike of ‘writing’ and an enthusiasm for practical work, especially where they have some real input into its design and interpretation. Jenkins advises caution in interpreting and generalising across these findings, but argues strongly that students’ views are valid and should be explored more completely.
Many influences affect the attitudes to science that students develop. Research on attitudes towards school science shows that they become less positive from age 11 to 12. Evidence gathered both from focus group studies and surveys suggests that children are interested in school science, but are less interested in science than in other subjects. This trend is not unique to the UK. It is common to all education systems in the developed world including Japan. Thus, whilst UK students perform well on the OECD PISA (Programme for International Student Assessment) tests, coming fourth after Korea, Japan and Finland in 2000, their attitudes towards science, one of the four elements of PISA from 2003, are a cause for concern. More recent evidence suggests that, in England at least, this decline in now beginning in the final year of primary school and that the prime cause is the overemphasis on revision for the KS2 (Key Stage 2) Standard Assessment Tasks (SATs), which place too much emphasis on recall.

Research suggests that the main factor determining attitudes towards school science is the quality of the educational experience provided by the teacher. Part of the explanation for student attitudes toward school science may be a shortage of well-qualified science teachers capable of providing a positive experience. Moreover, many science teachers are required to teach sciences outside their own specialism. This undermines their confidence, leading them to offer a significantly more closed and less stimulating experience. More insights into the nature of the problem come from a recent
extensive focus group study. Students complained that school science consisted of too much repetition and too much copying and note taking. They felt that they had been frog marched across the scientific landscape with no time to discuss any of the ideas or their implications. In addition, the gulf between science as it is taught and science as portrayed in the media made the relevance of school science questionable.

Science is unique among school subjects in that its curriculum aims to create future scientists rather than the future citizen. This produces a foundation curriculum whose coherence only becomes clear for those who stay the distance, and with it the value and meaning of the subject. Moreover, it is dominated by an assessment system whose predominant demand is low-level cognitive recall. Such a system promotes “performance learning,” which is extrinsically motivated, rather than “mastery learning,” which concentrates on the student, to the detriment of student engagement. Those who drop by the wayside are left with a few disjointed pieces of knowledge whose salience is difficult to comprehend.

1.11 Science Teaching at the School Level

The National Policy of Education (1986) has laid considerable emphasis on strengthening the science education in the school education. The qualitative improvement in science education depends on many vital components. The teacher is a crucial factor in the teaching-learning process.
He develops positive attitude in the learners for better achievement and the formulation and implementation of science education programmes. His teaching must be integrated with environmental based on real life situations using local experience, expertise and resources. The classroom territory must be expanded over the whole environment, so that the activities become supplementary to classroom teaching. If such an approach is systematically implemented with modification of needed resources, there may be improvement in science education at school level. In order to improve the quality of science education, the teaching environment for science is more important. The teaching environment for science includes infrastructure of the science laboratory, quality of the science text book, curriculum and the co-curricular and the techniques of teaching science. The success of the school science education depends not only upon the teacher, but also on the evaluation of the objectives of science teaching.

1.11.1 *Infrastructure of the Laboratory*

Science cannot be taught effectively with testing, experimentation and demonstration of the scientific facts. Science laboratory is the central place where students get an opportunity to conduct experiments and search principles of science. No course in science can be considered as complete without including some practical work in it. The practical work is to be carried out by individuals in a science laboratory because most of the achievements of modern science are due to the application of the experimental method. At
school stage, practical work is even more important because of the fact that learning by doing renders more meaningful education. Experiments help in brooding pupils experience and develop initiative, resourcefulness and co-operation.

The National Science Teachers Association of America (NSTA, 1982), in a position statement has defined the goals of laboratory as the laboratory is the place where students design and perform experiments, manipulate equipment, formulate hypothesis, interpret data and so on. It is here they use higher cognitive skills such as analysis and synthesis. Laboratory outcomes are concerned not only with the cognitive and affective domains but also the psychomotor domain, Bloom (1964). This psychomotor domain is very relevant to science, since laboratory activities require students to perform certain tasks such as manipulating equipment, and dissecting animal bodies and preparing, solutions etc.

1.11.2 Need and Importance of the Laboratory for Teaching Science

i. The laboratory encourages the students to perform their experiments carefully in a congenial environment.

ii. Laboratories are helpful in creating and promoting scientific attitude in the students.

iii. In the laboratory the students work in groups to develop a sense of co-operation and spirit of healthy competition, the traits very essential for getting desired success in future life.
iv. In science laboratory required apparatus, instruments, chemical and other materials may be kept safe, secure and ready for the use of observation and experimentation.

A well managed and functional laboratory providing optimum learning outcomes within the minimum time is the objective of the laboratory development. Laboratory experiences for the students serve as a powerful tool in making the teaching and learning process more effective. More participation of students in the laboratory activities would ensure development of confidence in them and the ultimate goal or development of the laboratory would be achieved.

1.11.3 Science Library

A science library should be an essential part of each school which undertakes science teaching. It is the most alternative and educative place lying in the campus of the institution. It is a calm, quiet and most proper place for the study as well as storing of all types of information. Students of all grades and classes may have sufficient material in it for enriching their knowledge of science. One of the important recommendations made by the Secondary Education Commission (1952-53) was that every school should have subject libraries which are under the charge of subject teachers. It was felt that subject teachers can enrich their teaching by making use of the collection of books.
All India Seminar on the Teaching of Science (1961) made some important recommendations about science library as follows:

i. Each School should have separate science library.

ii. Science books of general interest should be stored in the school library.

iii. Reference books are for use by teacher and also by students but these should not be ordinarily issued for home use.

iv. Books on methods of teaching science should be stored in a separate section in science library.

v. Teachers should encourage love for library books amongst his students and

vi. A few laboratory manual also should be available in school library.

The effectiveness of a science library depends upon the books and reading materials it possesses for its readers. It requires a proper planning and wise section on the part of the organisers. All the prescribed books for each standard, latest developments in science, science magazines and reference books related to the facts are to be kept in the science library.

1.12 Science Curriculum

Text books occupy a central and prominent place in teaching-learning process related to the study of any subject. They help the teachers and
taught to get acquainted with the limits and boundaries of the subject matter being taught or learning experiences to be gained with respect to a particular grade or class. The subject matter related to a particular subject written by experienced teachers and eminent authors is readily available to the students and teaches in the form of text books. The text books are considered quite indispensable at all stages of science education. The science text-book should aim at guiding the pupil in the development of personality and developing open mindedness, critical attitude in order to enable him to discover new knowledge to appreciate and understand nature and to mould it to one’s own ends and not merely stuffing of facts. The text books are very much useful in saving the time and energy of students as well as of the teachers. They are also helpful in maintaining the uniformity of the standard not only within the different sections of a school, but also within the different schools belonging to a region, state or country.

Text-books commonly include in the body of each section many suggestions for supplementary activities, experiments, demonstrations, reading, etc. The science text-books help to form correct understanding of basic concepts and principles of science. It helps to inculcate scientific attitude in the pupils and develop understanding about the scientific method. The science text books should acquaint the child with the wide variety of the application of the scientific knowledge through proper exercises. The text book should supplement meager experimentation that can be done in the
class room. It should give information about the past discoveries and some of the thrilling experience made by the scientists. It should give directions and problem solving. It should help the pupils for systematic and speedy revision of the lesson.

1.13 Importance of Science as a Subject

The importance of a sound scientific education for the younger generations is recognized by science educators of both technologically advanced societies and developing ones. The recognition of this importance is not, however, consistent with what we know about classroom practices in the natural sciences. These science are taught, divorced from the lives of students, the problems of the surrounding community, the global implications they may have etc. Science has specific applications in many of our activities. The contributions of science to the various branches of human progress are countless. One can marvel at the advances made in medicine, astronomy, agriculture, engineering, oceanography, aeronautics, space travel, Micro-Biological Science, nuclear Biological Science and innumerable branches and sub branches of scientific study.

In this age of scientific and technological advancement, every body should have at least some basic knowledge of science for making effective and useful contribution to life. The report of the Education Commission comments that, “there is one thing about which we feel with no doubt of hesitation, that is science based education incoherence with Indian cultural
and values can provide the foundation as an instrument for the nations progress, security and welfare”.

Science has now become a compulsory subject in the school curriculum because of its multi-various value to the individual as well as to the society. It develops values – social, cultural, moral, aesthetic, intellectual and vocational, among the learners.

The study of science develops scientific attitude among the minds of the students. Science is a way of doing things. As a result, a student is involved in conducting experiments or the laboratory work. This also involves feelings and values. Attitudes reflect feelings of a person. A person having scientific attitude is never superstitious. He forms his conclusions only on the basis of his experiences. He searches for natural cause or basic reason behind the superstitions passed on to us from our forefathers. He is always curious to know about his environments, his surroundings and existing things and is always ready to know and learn more about them. His mind is like a sea with open mouth ready to gulp down new facts. Further, study of science trains the learners in scientific method of solving the problems.

1.14 Teaching Science in the Conventional Methods

Techniques of teaching are the classroom activities which the teacher may design for a particular lesson. They may include group discussions,
projects, use of the textbook and field tripping. The term “technique of teaching” means “art of teaching”. The art of teaching is the art by which a teacher uses certain principles, procedures and means to teach his students in class or individually, in such a way that the student gets an opportunity to make his all-round development.

A teaching technique can be thought of as an activity which affects the learner's encoding process, that is, how the learner will learn the desired information, concept, generalization and skills. A great variety of teaching techniques are being used in modern Indian schools. There is no rigidity concerning this because the educator chooses his technique to suit the occasion, the subject, the class and the availability of facilities. The teaching techniques should be flexible, and the methods employed should flow from one to the other. The science teacher need not insist to a particular method during the whole period. The teacher should change from one method to another to create desirable climate for learning. Some instructional methods are effective in developing particular kind of values and others may help to cultivate different values. There are many methods in teaching science. They are as follows:

1.14.1 **Demonstration Method**

Demonstration is an act to display working of some experiments. It is one of the most versatile and useful methods of teaching science. Students
actually see the experiments. They learn handling of apparatus and verbal ideas are replaced by concrete objects. If the teacher is well prepared with demonstration, it has the desired effect upon the students. In this method of teaching, the teacher performs experiment before the class and simultaneously explains what he is doing. Demonstration method is used by good science teachers for imparting science education. This method combines the instructional strategy of information imparting and showing how. It is less expensive. In this method all the students see the same operation and techniques. In case of dangerous experiments student’s mishandling is saved. Verbal instructions are concretized for the students.

1.14.2 Biographical Method

Young people are usually fascinated by interesting stories. In this method, the lives of the important scientist are described in an interesting manner and simultaneously their achievements are discussed in the class. The events of struggle and achievements of the great scientists arrest their attention and make the study of science interesting. This attitude provides great incentive to the study of science. The protagonists of this method of teaching science suggest that the pupil should try to project himself into the life of the original discover, to experience his successes and frustration, to appreciate his hopes and disappointments.

1.14.3 Historical Method

Historical method believes that children’s ideas and thinking follow the
same historic route of original discovery of a scientific phenomenon. In this method to start from the discovery of the scientific phenomenon and pass through the actual course of its development from the earliest beginning. This way of developing the topic is fascinating to the pupils and it appeals to them. This method is started with an interesting incident or story of the lives of scientists leading to a particular scientific discovery such as Archimedes and his bath or Newton’s curious thought over the falling of an apple, which led to the discovery of two most important theories in science. This method can be conveniently used for the exposition of important theoretical concept in science.

1.14.4 Topic Method

This method is a sort of approach to a subject rather than a method of teaching and that its final aim is to establish the principles from facts rather than the reverse. In this method, the teacher selects a topic of general interest and one that is easily experienced by the pupils. He develops around the topic a series of lessons or units. For example, in the topic of the study of ‘air’, which is of immediate interest to the pupils, around air, the teacher can develop a series of lessons such as properties of air, its constituent gases $O_2$, $N_2$ and $CO_2$, etc. Various appliances using air-barometers, pumps, syringes, uses of air-respiration, ventilation, air-conditioning, etc. It is more real to them when they understand the points of the lesson.
1.14.5 **Heuristic Method**

It aims to put the pupil in the attitude of the discover, or better, of a researcher and he should be helped to make his discoveries. In this method each student has to solve scientific problems experimentally, think for himself how to proceed, observe carefully and note down the essential data, analyze the data and draw conclusion. In a way, he is placed in the position of the original investigator. Heuristic method is indisputably an excellent approach for training students in scientific method.

1.14.6 **Laboratory Method**

The laboratory method of science instruction is characterized by the students (either alone or in small group) actually producing and manipulating the different variables that are under exploration. It is 'child centered' in its approach rather than being "subjects centered". The common expression is that laboratory work involves "hands on" exploration. In this method, the students are encouraged to derive the laws and principles of science themselves by actually performing the experiments. The students are given all necessary materials and equipments in the laboratory along with proper instructions for carrying out their experiments with their own initiative and effort, then they carry on the experiments and record the observation and infer their own results. They learn by their own experience, observation, testing and verification. The teacher supervises their work and also guides them wherever needed. This method keeps the student always alert and
active, knowledge gained through this method is more lasting and permanent.

Laboratory method can rightly be called a psychological method as it suits the nature and interests of the learners. It helps in satisfying their urges of self-doing, exploration, creativity and inventiveness and proves a helping hand in realizing the psychological needs of the children. It paves the ways for the exploration, experimentation and verification of the scientific facts and principles. The experimental work trains them in the development of virtues like truthfulness, honesty and sincerity as they conduct their experiments honestly and records the observations and draws the inferences truthfully.

### 1.14.7 Project Method

Based on the principle of ‘learning by doing’, and ‘learning by living’, this method is a type of problem solving method. The students workout problems selected by themselves, investigate them and solve them in groups or individually. Spontaneity is the essentially quality of the projects as project grows out of children’s own purpose. A project is a whole hearted purposeful activity proceeding in social environment. It is a unit of activity in which pupils are made responsible for planning and purposing. Project is the core and heart of this method. For carrying out the solution of a day-to-day felt need or problem, the students pick up a suitable project to be completed in a
co-operative way as naturally as possible. The definite planned steps necessary for doing the project method is providing a situation, choosing the project, planning, execution, evaluation and writing report or recording of the project.

1.14.8 Assignment Method

In assignment method, the whole syllabus is divided into well planned portions called assignments to be coursed in a particular month or week. A topic is taken and the teacher issues instructions with references from the books with page and paragraphs. Students study those pages, write the answers and draw diagrams etc. The teacher checks these note books and points out their mistakes for correcting their errors. The students correct their mistakes themselves and so do not repeat them again. This part of assignment is called home assignment. The second part of assignment is laboratory assignment. After successful completion of the first part, the teacher may enter the names of successful candidates in assignment card and issue instructions for laboratory work. The success of an assignment depends upon its proper planning, by this Apparatus can be improved. The students learn working independently. They themselves find books, collect mater and organize it. Students learn the habit of extra study.

1.15 Need for Alternative Methods of Teaching Science

It is necessary to revitalize science teaching and especially teaching of Biological Science, to help the learner acquire knowledge, skills and
critical thinking in an interactive environment. It has often been noticed that there is an increasing gap between the promises made in the curriculum and what is happening at the level of the child's perception. Where the ratio of teachers to students is much below the required norm in many areas, individualized-self learning methods could also be used as a supportive system. It is important that the process of learning should promote the spirit of inquiry and creativity among both children and teachers.

In order to make the process of learning participatory, there is a need to shift from the mere imparting of information to involvement in debate and discussion with the help of Audio/Visuals. This approach to learning will keep both learners and teachers tuned to science realities.

Individual differences are as important as cultural differences. Each child has capacities and skills which do not find adequate recognition in the school environment. Development and flourishing of these skills and capacities would not only enhance the individual’s life but also enrich the life of the community. Teaching must therefore promote and nourish a wide range of capacities and skills in our children as possible. Using the textbook becomes the most expedient way to teach, and the student often becomes a passive receiver of more information than one could ever hope to comprehend, analyze, and encode. Hence, the shift away from rote learning to comprehension through the implementation of new alternative methods in teaching/learning is imperative. Learning should involve freedom, flexibility,
relevance and transparency in the selection of content and transaction. Emphasis may be given on active, student-centered approaches of learning where students are given the opportunity to discuss, think, analyze and develop the skills necessary to understand cause and effect, and change. This will help to provide an opportunity to shift the emphasis from information-based and teacher centered education to process centered and learner friendly education.

Similarly, science teaching needs to be revitalized for helping the learner acquire knowledge and skills in an interactive environment. The teaching of the science must adopt methods that promote creativity, aesthetics, and critical perspectives, and enable children to draw relationship between past and present, to understand changes taking place in plants and animals. Teaching should utilize greater resources of audio-visual materials, including photographs, charts and maps, and replicas of archaeological materials. In order to make the process of learning participative, there is a need to shift from mere imparting of information to technology enriched methods.

1.16 Innovative Methods for Teaching Biological Science

There are Alternative methods of teaching in Science including Biological Science. They are Spatial dynamics, Active learning, Learning by Teaching, Dramatization, Computer-based Training.
1.16.1 Spatial Dynamics

This is an instructional strategy wherein students create large-scale models that capture their interest by allowing them to participate in learning. Participation is maximized because students are involved in design and construction of the models. Spatial dynamics activities motivate and enhance the learning of students of all ability levels and grade levels. Learning styles are not accommodated as much by traditional methods as in spatial dynamics.

1.16.2 Active Learning

Active learning inherently implies a “doing” approach. Here the teacher adopts a constructivist approach to learning which calls for performance and persistence from the learners. This method includes simulations, strategy and role-playing games, storytelling structures, case studies, Socratic dialogues, etc.

1.16.3 Learning by Teaching

Learning by teaching is a method teaching which allows teachers to share new lesson content with small groups of students. These students prepare their part in order to teach this content to the rest of the class.

1.16.4 Dramatization
In this method students dramatize the biological events. Students enacting the drama have the opportunity to freely question, pretend, and imagine within the context of historical and cultural knowledge. Any character developed for first person historical narrative presentation circumscribes the historical or cultural knowledge of the time and place.

1.16.5 Computer-based Training

Computer-based training, also known as computer-assisted instruction (CAI) or computer-assisted learning (CAL) is an instruction delivered through a computer. Originally, it was text-based, but most computer-based training programs now encompass many multimedia elements. Multimedia simply means a variety of media together. It may be the combination of text, audio, still or moving pictures and animations.

Further, interactive multimedia requires the participant to interact with the computer by completing exercises, answering questions and solving problems.

1.17 Technology of Teaching Biological Science

Educational Technology could bring about a major improvement in the ability of the students to read, write and reason and in order a more effective leaning takes place. This might transform learning Biological Science into something more enticing, more valuable and more widespread.

Computer tasks of reading, writing communicating problem-solving
and researching are embedded in technology (Dougiamas, 1988; Halpin, 1999; Cohen, 1993). Students should utilize technology as a mode of learning, rather than as a tool within the existing system. Technology is capable of changing the educational signpost at the gateway to the future. It can create learning environments that are realistic, challenging, interactive, and immersive.

Information and Communication Technology (ICT) in the integrated form such as internet and multimedia is expected to play crucial role in enhancing access to educational resources and in improving the quality of learning. The revolution in technology has a tremendous potential to revolutionize education and transform school dramatically. It is hoped that the monopoly of formal education and the conventional learning method will diminish with a lot of new educational exposure. The teachers will become facilitators and the learning will become more individualized and interactive. The ICT is bound to influence and transform the existing educational provisions, changing the existing curricula, bringing in a new generation of learning methods and materials and encouraging the networking of schools.

The teaching methods commonly employed to teach Biological Science in the school level is lecture method. This current system of teaching and learning Biological Science is not effective since non-usage of any educational media. Moreover, this conventional method is teacher-
controlled and not learner-centered. The individual differences of the students are not catered too. These problems could be effectively solved by the use of multimedia as a new instructional strategy, which could be used as supportive strategy also.

Integration of ICT into schooling would demand that the educational planners look beyond the current urban classrooms devising updated plans for education in an electronic environment. It is not merely integrated into an existing curriculum, instead it becomes an integral part of the schooling process resulting in universal computer literacy, computer aided learning and finally, computer-based learning throughout the country. All innovative experiments in the areas of media production and the interactive video and multimedia computer software shall have to be perceived as integral components of the curriculum development process rather than external to it. It would necessitate the teachers to adopt an instructional design that helps the learner master heuristic and algorithmic strategies for tackling new problems as opposed to strategies aiming at the mastery of discrete units of some fixed knowledge.

It is not only the teaching style that would be influenced by the ICT but also the learning style. This would result in a shift from the traditional learning atmosphere to a climate of values that encourages exploration, problem-solving and decision-making and from the prescriptive classroom
teaching to participatory, decentralized, interactive and strategies that unify knowledge, the mastery of fixed body of knowledge to understanding of a web of interrelations between parts of a whole, the linear sequential reasoning to search for patterns and connections and the collections of information to the processing of information. Building alternative/ supportive methods for teaching Biological Science in addition to conventional method is the need of the hour. Whatever alternative systems exist on the ground need to be made less bureaucratic in their operations, and they should also, be reoriented to carry out their tasks more efficiently.

While integrating ICT for teaching Biological Science subject, it is imperative that the media choice must relate to instructional design as well as to what is available and eminently usable. The same is true of methods and techniques. Models, charts, textual materials, experimental kits, projected electronic aids, audio materials, computers, films, videos, the Internet, etc., can usefully serve the purposes of learning Biological Science subject in their own special ways and together they can make learning an enriching experience.

1.18 Multimedia in Biological Science Teaching

The use of multimedia in teaching the growing popularity of, in the process of using high school Biological Science teaching-related issues have emerged, and to reflect on these aspects: processing good teachers,
computers, student relationship, proper handling of the screen, blackboard, and student relationship. All parts of content creation, production of courseware and courseware interactive use, there must be selective use of courseware authoring software. Multimedia-assisted instruction is computer technology, network technology, multimedia, and the integration of modern educational theory, it is illustrated, the picture dynamic, visual image, to enable students to audio-visual synchronization, and used to optimize the teaching environment and atmosphere, and greatly enhance the student learning interest. Students can fully mobilize the enthusiasm and initiative, to develop students awareness of innovation, to improve classroom efficiency and reduce the burden on students."To the teaching content, textbooks, the reform of systems and methods based on educational technology platform."

With the rapid development of computer technology, the population gradually through the peaks and the continuous development of socio-economic and long-term with multimedia devices are increasingly affected by the pro-gaze of classes, and will increasingly reflect its advantages.

The multimedia teaching equipment, after-school classes of biological problems encountered with the thoughts, mainly the use of multi-media aspects: First, deal with teachers, computers, student relationship in terms of equipment multimedia classes, teaching advanced equipment, teachers can direct care to each student. Changed the original "classroom-centered, teacher-centered, to textbook-centered" teaching system, students from a
passive position, give full play to their principal role. Should be said that classes in multimedia equipment, regardless of mode of instruction, teaching content, teaching methods, or in the mobilization of students, sensory, and raise their interest in cognitive, physical and mental development of students consistent with the law, but in practice, or there are many problems to be discussed. In conventional teaching, Biological Science teachers to teach directly to their knowledge to their students. In the equipment, multimedia classes, teachers are teaching through their own understanding of the presets to the computer and then pass on to students. In the teaching process, first teaching content is preset and cannot be adjusted according to actual classroom work; it is likely to cause the actual teaching and the students out of touch. Second, since the content is a pre-built, not very flexible, and easy to put the students detained in the computer program is not conducive to the cultivation of creativity of students. Third, the lesson in the manner often used to complete the courseware, teachers, easy to own most of the time spent on the operation of multimedia devices, the relative shortening the time for emotional communication teachers and students. As time goes by, will alienate teacher-student relationship is not conducive to the establishment of the students of biological study and emotion.

Thus equipped with multimedia teaching of Biological Science classes to deal with good teachers, computers, the relationship between the students can not evade reality.
How to deal with these three relationships? First, teachers must be clear of modern teaching, media is an extension of traditional teaching media and development, it has many advantages, but it is after all not a "panacea." In traditional teaching media, there are deficiencies; there are many aspects that can never be outdated and invalid. One thing is certain, the most advanced teachers teaching media cannot be replaced. Second, the Biology teacher in lesson preparation must better understand the students’ practical, taking into account each student to occur, resulting in a comprehensive consideration to the problem and set to the courseware to prevent the teaching out of touch. Third, we must provide more heuristic problem, so that every student in the class had answered, participation, and fully utilizing the opportunity of thinking. Teachers should allow students to feel that teachers have their eyes everywhere. As long as Biology teachers pay more attention in class and this is easily done in. Fourth, in order to go to the students, teachers must be able to skillfully use and operation of multimedia equipment. For example, the use of remote control mouse both teachers go to students, but also manipulate the teaching platform to control the teaching content. Essential and timely consolidation of practice Biology lessons, teachers, students to practice manipulating the stage when you cannot just stand, cannot be completed immediately after the students through the courseware, or other media player results. But in practice the process of view, to guide, and to discover in the course of inspection of various issues
and students the correct answers through in-kind projector to display and compare students to discover and summarized. This will not only eliminates the distance between teachers and students, but also played the main role of the students. Fifth, the use of courseware in the classroom teacher is best not to voice input, as fully play courseware is easy to enable students to become the audience, ignoring the dominant position of students, restrict student explorations of abstract thinking ability and innovation. Through the screen and teachers direct talks and to achieve better results. Modern teaching and learning process in the classroom, should be familiar with the characteristics of modern educational technology, must skillfully use these technical features, in order to achieve the teaching objectives. Only by continuously summing up multimedia equipment, teaching classes, dealing with good teachers, computers, and the relationship between the students can really play a large area to improve the quality of Biology teaching effect.

This is an age of knowledge explosion where traditional methods of verbal instruction could not help to keep pace with the development of knowledge. The word has crossed the threshold of new information, multimedia era, which is the mantra of today. Multimedia is the latest buzzword in the educational process.

Multimedia is extensively used in education, especially in schools, and at class rooms. Multimedia education facilitates one to proceed at his or her
pace. Television programmes combine sound, video, graphics and text. While the multimedia has all these facilities. It also has special capacity to interact. A multimedia user is able to decide what information should be delivered by the newscaster and in what sequence. The user controls the programme by pressing a key or clicking a mouse button or touching a screen.

There are two kinds of interactivity: functional interactivity and intentional interactivity. While functional interactivity manages the human to machine interface and describes with a machine and its software and in intentional interactivity the communication takes place between the investigator and his target, describing the re-construction of a dialogue between a physically absent investigator and his interlocutor. Obviously, television and video programmes seem less interactive than the computer at a functional level.

The books read the content written and the television watched, lack creativity. With the inclusion of key board and mouse, a computer can easily accept a users input. Here, the user is allowed to take control of program execution. When the user clicks the 'hotspot' (hypertext/hypermedia), it will display another file in the program, which is linked (hyperlink) file, which can be sound file, a digital video clip or image file with new information. In this way, a personal computer is becoming the interactive multimedia today.
Multimedia comprises computer graphics, images, sound, motion, animation, text and text reproductive system (Sullivan, 1955). Heim (1993) maintains that the key aspect of multimedia is offering a replica of real environment of objects that fools our senses into perceiving the multimedia as real. Computer multimedia is built from real world situations. Because reality is complex, models are built to simplify the reality so that it can be easier to study its most important features. Students can never write well about something until they had thought well about it. Multimedia are opportunities to work with how to think well about fairly complex matters. Thus, multimedia exemplifies how to enhance the learning effectiveness by utilizing various technologies and methods.

Educational multimedia is metaphors designed to focus learners attention towards concepts, which allow them to explore artificial environment, imaginary based on reality. The educational multimedia also provides a good opportunity for exploration, experimentation and interaction. The learners can experience the consequence of their actions without facing a risk. Leon and Leon (1990) maintain that with a multimedia, the students are in control of the learning environment. It is upto them to find and use information in order to draw conclusions. Multimedia allow students to have experiences that would not be possible otherwise. Instead of simply spewing facts, multimedia provide a context for knowledge. Thus these multimedia
technologies offer an opportunity to bring elements of active practices into the classroom.

Biological Science occupies a unique position in the school curriculum. Biological Science is central to many science related courses such as medicine, pharmacy, agriculture, nursing, biochemistry, and genetics so on. It is obvious that no student intending to study these disciplines can do without Biology. These factors, among others, have drawn attention of researchers and curriculum planners towards Biological Science as a subject in the school curriculum (Kareem, 2003). In spite of the importance and popularity of Biological Science among students, performance at secondary school level had been poor (Ahmed, 2008). The desire to know the causes of the poor performance in Biological Science has been the focus of researchers for some time now. It has been observed that poor performance in the sciences is caused by the poor quality of science teachers, overcrowded classrooms, and lack of suitable and adequate science equipment, among others (Abdullahi, 1982; Bajah, 1979; Kareem, 2003; Ogunniyi, 1979). Students perform poorly in Biology because the Biological Science classes are usually too large and heterogeneous in terms of ability level. In addition, the laboratories are ill-equipped and the Biological Science syllabus is over loaded (Ahmed, 2008; Ajayi, 1998).

As multimedia teaching technologies become more widely advocated
and employed in education, researchers strive to understand the influence of such technologies on student learning. Advances in technology enable pedagogical enhancements that some believe can revolutionize traditional methods of teaching and learning (Gatlin-Watts, Arn, Kordsmeier, 1999; Persin, 2002). Studies of multimedia-based instruction report a variety of outcomes (Cabrero, Rodriguez-Conde, Juanes, and Cabrero, 2005; Dimitrov, McGee, and Howard, 2002; Everhart, Harshaw, Everhart, Kernodle, and Stubblefield, 2002; Feeg, Bashatah, and Langley, 2005; Homer et al., 2000; Kealy, 2003; Liao, 1999; Mayer, 1997; McKethan and Everhart, 2001; Moreno and Valdez, 2005; Neuhoff, 2000; Smith, 1997; Smith and Woody, 2000; Sneddon, Settle, and Triggs, 2001; Trindade, Fiolhais, and Almeida, 2002; Welsh, 1993). When viewed collectively, these studies reported that advanced technologies, especially multimedia instruction, which often involves introducing or enhancing the visual aspects of the presentation of course contents, created an active learning environment, improved students' performance, fostered positive attitude towards learning complex concepts, increased communication, and could be adapted to all learning styles and levels of instruction (Harris, 2002). Researchers suggest that, compared to classes with a traditional teacher-leading approach, those using multimedia are better liked by students and yield slight but statistically significant improvements in student learning as measured by both student self-report and objective outcome testing (Dimitrov et al.; Feeg et al.; Mayer, 1997;
McKethan and Everhart; Moreno and Valdez; Sneddon et al., 2001; Worthington, Welsh, Archer, Mindes, and Forsyth, 1996). Such encouraging findings have precipitated the adoption of these technologies on a widespread basis. Despite many studies suggesting that multimedia instruction benefits students, there are also some that found no significant differences between multimedia classes and traditional classes (Everhart et al., 2002; Homer et al., 2000; Lee, Gillan, and Harrison, 1996; Stoloff, 1995). Therefore, there is a need to further educators' understanding of the effect of multimedia technologies on students' learning quality.

Thus to ascertain the effectiveness of Multimedia it would be reasonable to compare it with classroom instruction. A number of studies (cited in Najjar, 1996) have been conducted in the area to ascertain the effectiveness of multimedia instruction. Analysis has been done by Bosco, 1986; Fletcher, 1989, 1990; Khalili and Shashaani, 1994; Kulik, Bangert, and Williams, 1983; Kulik, Kulik, and Bangert-Drowns, 1985; Kulik, Kulik, and Cohen, 1980; Kulik, Kulik, and Schwalb, 1986; Schmidt, Weinstein and Niemic, and Walberg, 1985 by examining 200 over studies. The information included sciences, foreign languages and electronics. The control group normally learnt the information via classroom or lecture combined with hands-on experiments. The comparison group learnt information via interactive videodiscs or computer based instruction. The achievement of learning was measured via tests taken at the end of the lessons. Over this
A wide range of students, meta-analysis found that learning was higher when computer-based education was used. Learning also appeared to take less time when multimedia instruction was used.