CHAPTER - 1

INTRODUCTION

Education is becoming truly global now a days and new wave of Information and Communication Technology has opened newfangled prospects in the delivery of education. Personalized intellectual avatar like tutors, intelligent learning clouds, intelligent campuses, mobile learning, e- learning, blended learning, affective learning, and immersive reality are the new intelligent environments which are fetching innovative pedagogical developments and has revolutionized the contemporary learning practices to challenge the traditional notion of teaching and learning. Intelligent environments have heralded that Information and Communication Technology will transform the society radically by passing revolution in teaching learning process. So the dire necessity arises to research better technological solutions for better teaching learning environments.

Educational systems all over the world are under increasing pressure to use the new Information and Communication Technologies (ICTs) (UNESCO, 2002). The premise that ICT is important for bringing changes to classroom teaching and learning, is the basis for this pressure. All countries are investing very high amount in ICT due to the tremendous efficacy of ICT in teaching learning process.

Evolve ments in Information and Communication Technologies have revolutionized the classroom and will continue to transform the way teachers instruct their students. New infrastructure and physical facilities including Information and Communication Technology which comprises equipment and tools like radio, television, video, mobile phones, computer, satellite, network, hardware, software, DVD, CDs and services like videoconferencing, electronic mail, search engines, etc. are accessible for utilization and need of the individual. As a result of this, new options for instructions are accessible. New concepts such as virtual teaching, team teaching, collaborative learning, individualized and automated instructions compel educators to vary, innovate, modify and transform instructions.

New concerns for the individual learner and new ways of presenting information must be considered, if we have to produce effective design of instruction. The instructional phases of teaching consist of developing intentions, regarding the
strategies that the teacher plans to use, while planning for instructions. Recent developments have made feasible for teachers to conceptualize a variety of instructional strategies. Representation of these strategies in concrete models of instructional intent gathers data about their instructions to see if their instructional intentions are actually carried out in the classroom. The ultimate goal of instructional phase of teaching is to facilitate student learning and promote higher-order thinking skills.

1.1 INSTRUCTION

The teachers, when connect students in classroom activities for the purpose of facilitating student learning and strengthening apt learning, they are instructing the students. Afterwards it, then follows, that most of what occurs, in classrooms can be described as instructions. Teachers must instruct by using a variety of instructional strategies, activities and materials. If the purpose of these activities, strategies and materials is to modify student behavior in terms of stated instructional objectives, then the activity is defined as instruction. Instruction in general can be defined as, deliberate arrangement of experiences to help a learner to achieve a desirable change in performance.

In an instructional plan, teaching learning process is systematized. The intention of instructions is to make the learning ensue. Instructional plan inspire, stimulate, motivate and encourage the learners to learn. According to Gustafson (1996), instructional design is about:

a) Critically assessing what learning outcomes is to be achieved
b) determining what pedagogical strategies are to be adopted
c) Try out as well as revision of the instructional plan
d) Analyzing whether stated objectives are attained by the learner

Instruction is an organized progression, the teaching elements (i.e. teachers, learning environment, students and resources) are essential for effective learning. Teaching and learning activities are associated with instruction. Instructions should motivate, scaffold and encourage the learner to construct the new knowledge and the knowledge should be durable. For this, students are required to know and learn how to scramble, practice, construct, process and recollect knowledge.
1.2 EFFECTIVENESS OF INSTRUCTION

Those instructions are said to be effective instructions which imbibe knowledge, attitude and the learners have acquisition of specified skills (Reiser and Dick, 1996). To make the students self learners effective instructions are very much essential, for this, students must be self motivated and to motivate the students all components of instruction must be considered important and determined pre hand. For effective instructions some norms or guidelines must be followed like:

a) After giving the due importance to the desirable learning outcomes to be achieved planning for the instructions should be done accordingly.

b) Instructional activities should also be planned according to predefined learning outcomes.

c) Develop such type of assessment and evaluation tools that will measure attainment of predefined learning outcomes.

d) Instruction should be revised according to students’ performance and their attitudes towards imparted instructions.

Above prescribed guidelines should be followed by the teachers, so that they can impart instructions effectively, fruitfully and productively. When ever instructional design is made it is always assured that instructional process is properly planned, developed, evaluated and managed. Instructional design is always prepared from the learner view point than from content perspective, while designing the instructions it is ensured that students should perform that activities via which pre defined learning outcomes or goals can be achieved.

According to Kemp, Morrison and Ross (1994), effective instructional process is that process, which comprises those features which stimulate the students to achieve the desired learning outcomes. It also comprises:

i. Individual students’ readiness to achieve the learning outcomes.

ii. Adoption of appropriate teaching and learning methods according to individual difference and pre defined objectives.

iii. Adoption of appropriate media or resources.

iv. Adoption of other support i.e. other than the teacher and available facilities.

v. Criterion to be adopted to determine the achievement of objectives.
vi. Requirement of revisions of the instructional process, if it does not match with expectations.

The above prescribed considerations are related with the objectives as the basic objective of the instruction is to achieve the predefined learning outcomes via varied instructions.

The main key elements of instructional design are: Whom to teach, what is to be taught, how to teach an how to assess and evaluate.

I. Whom to teach: for this the teacher must know the level of students to whom she is going to teach and to know the behavior of learners is very much essential. When the teacher has knowledge about the learner’s behavior only then she can design the instructional activities for the learners.

II. What to teach: In this process teacher must have the knowledge about the content matter and should frame the learning outcomes accordingly and those learning outcomes should be SMART i.e. specific, measurable, achievable, realistic and time specific.

III. How to teach: In this process teacher must be aware and have the ability to design, that specific instructional activities via which pre defined learning outcomes can be achieved and plan the pedagogical techniques and tool accordingly.

IV. How to evaluate: formative and summative assessment of the students plays key role to acquire the information whether students have pre defined learning outcomes so assessment tools should be designed with precision and these tools must be reliable and valid so that learning outcomes can be easily achieved. Varied type of assessment tools like rubrics, multiple choice questions, long answer type questions, true false, matching, short answer type questions, home work assignments, problem solving questions, case studies etc. can be designed to achieve the learning outcomes.

Kulik and Kulik (1980) after doing the varied review of researches on the in individualized approaches to teaching, basically, mainly on personalized system of instructions (PSI), concluded that the personalized instruction modes generally resulted in higher achievement and better long range retention at the end of the course material.
No one definition of excellence in teaching prescribes any standard against which all teaching is to be compared. A good strategy for defining excellence in teaching is to consider three major areas that can be emphasized in defining teaching. These are input process and product. In general, the evaluation of effectiveness of instructions can be divided by its emphasis on input (What do students and teachers bring to the classroom?), or process (what do teachers and students do in a course?), or product (what do students learn or accomplish in the course?)

1.3 INSTRUCTIONAL DESIGN

Designing of the instructional process plays central role in achieving the instructional objectives. There are so many elements and factors which are considered for designing an effective instructional design and all factors are dependent upon each other. Organization of all factors is very much important. It is a major responsibility of the designer to give due prominence to the all steps to be followed and design the teaching learning activities accordingly, every step should be associated. There are numerous elements that need to be taken into account in the instructional design process. The magnitude of the affect in these elements can not be overseen. These elements should be explicitly organized in the instructional design. In the instructional design process, all the steps are co-related. If there is adversity in any of the steps, then the subsequent and following steps will be in disagreement due to inept items in the preceding step. Therefore, it is imperative to align the steps in order to ensure logic and relevance with other steps.

For example, if the objectives, learning outcomes or goals are not framed specifically or suitably then the next step will get affected automatically as a result of this prime tribulations will commence due to faulty previous step. Due importance should be given to each and every step and there should be some logical interconnection with one another step. Incomplete or in appropriate instructional design can not help in achieving the learning outcomes.

Instructional designer should collect all the information regarding learners that is about their level, background and their prerequisites learning etc. afterward, accordingly learning outcomes are to be designed. An instructional design imparts all the
information regarding methods and how and instructional design will be implemented in the teaching learning process. Instructional designer should refer varied models of instructional design to solve the problems of teaching learning process and to over come the varied problems to measure learning outcomes. Instructional design model is given in Fig 1.1:

**FIG.1.1: INSTRUCTIONAL DESIGN MODEL**

From the figure (Fig.1.1) it is apparent that instructional design model comprises the input, process, output, feedback and learning in terms of outcome. Input
is the first and basic of all activities for learning and teaching. This is the first step in instructional design towards which, instructor is concerned the most, as the designer he should first of all recognize the leaners’ need, level, behavior and prerequisites of learning. If the there is information about the input only then designer can make out what methods are to be adopted for teaching particular content.

I. The input: in this process 5 stages are involved mainly (a) Need Identification (b) Content Identification (c) Goals and objectives identification (d) Teaching methods identification (e) Instructional media identification.

(a) Need Identification:

The identification of need arises from the need assessment of a specific curriculum. The instructional designer must identify the need why students need to learn particular content and for this, there are certain ways like interview, observation and survey which need to conducted to collect data pertaining to this.

(b) Content Identification:

From the curriculum the contents are selected which is to be taught and contents are selected according to learners’ need.

(c) Goals and objectives identification:

Goals and objectives play a pivotal role in instructional design model as outcomes explore only what students will learn, understand, explore or analyze after the instructional process. The outcomes are derived from the content. Learning outcomes in terms of behavioral outcomes are classified as intellectual, verbal, cognitive, motor skills and attitudes; the main emphasis is focused on cognitive, affective and psychomotor domains while learning outcomes are designed. Learning outcomes are usually attained in terms of intellectual skills, psychomotor skills and affective skills.

Students acquire, learn and develop different type of skills for solving different type of problems and progress as self learners when the learning outcomes are achieved and appropriate teaching activities are designed.

(d) Teaching method Identification:

Teaching methods to be adopted plays very important role in achieving the
learning outcomes. Teaching methods, to be adopted, should be selected very carefully and appropriately. All selected methods should be according to content and student’s level.

(e). Instructional media Identification:

Instructional media comprises tools and resources to be used for imparting instruction these are basically used to impart instructions in an effective way. Instructional media can be categorized as (i) Traditional instructional resources (ii) Modern instructional resources

(i). The traditional instructional resources comprise books, magazines, journals, graphs, charts, models, pictures, posters, cartoons, newspaper, dioramas, blackboard, field trips etc.

(ii). Modern instructional resources comprise radio, films, telephone (both fixed and mobile), television, computer, data projectors, multimedia, internet, satellite etc.

Pedagogical resources for imparting instructions are also useful for making the lesson interesting, durable memory, motivate the students and to communicate the topic in an effective way. Selection of instructional media is dependent upon the learning outcomes and contents, need and teaching methods. For the construction of new knowledge the instructional media also plays a significant role.

II. The process: process step comprises basically 3 phases which include test prototype, redesigning of instructional activities.

(a) When ever the planned instructions are tried out it is always done in the first phase i.e. test prototypes. The main goal of first stage is to find out which stages are working and which stages are not working. In other words, the problems in instructional design are identified during testing prototypes. Testing prototypes tells instructor what students really want to learn and how to get there.

(b) When some difficulties problems or issues are faced then the instructions are redesigned which is done in second phase. Instructional designer reorganizes instructional activities. To reorganize instructional activities, pre-testing plays a key role to design an effective instruction. If an effective instruction is designed well, instructional goals will be achieved successfully.
(c) The third phase is the implication of instructions. It comprises the teaching activities pertaining to content, methods, goals or objectives, instructional resources etc.

III. The output: This stage comprises two stages one is assessment and another one is revision of instructions.

(a) Teaching and learning processes planned in instructional design model are firstly assessed, which is done by using both formative and summative assessment and evaluation. Basically the assessment is done to know about the extent of achievement of goals and objectives. Assessment and evaluation explores about the level of involvement of the students in teaching learning process, level of academic performance, attitude, and level of development of specified skills, moreover teacher also gets an idea or knowledge that, students have learned what is supposed to be learned. Teacher should design the assessment and evaluation tools accurately, judiciously and carefully.

(b) After analyzing the result the careful observation is made for the problematic areas then discrepancies are recoded. Carful decisions with precision are made for redesigning and revamping of instructional activities, according to desired need and outcomes.

IV. The feedback: feedback step has one stage. This is “Go back to related step”. The feedback process involves revise instruction based upon the data collected during the implementation phase. If, during the phase, teacher finds that students are not learning what the plan wanted them to learn, and they are not enjoying the learning process, teacher want to go back to related step and try to revise some aspect of their instruction so as to enable their students to accomplish their goals. If there is a problem in input step, instructional designer will go back to input step. Then, instructional designer will make changes and start process from input. This process will be done until all goals and objectives are learned by learners. During this cycle, instructional designer may go back to any steps to where a problem has occurred.

V. The learning stage: this stage has only one step that is learning and it finally leads to the attainment of learning outcomes. This stage emphasize on life long learning.
During this stage teacher tries to give his best via instructions, so that students should learn what she wants them to learn. If the goals or learning outcomes are achieved via the planned instructional activity then she plans for the new activity. The philosophy behind the designing of the Instruction is the constructivism, behaviorism and cognitivist theories. As during teaching learning process students are made active by engaged learning and they recall, remember, understand, evaluate, apply and synthesize to construct new knowledge. Basically instructional design should be make like this that they must use cognitive, constructivist or behaviorist learning to achieve the desired learning outcomes so that they can have long term memory. Long term memory is planned by the instructional designer.

For long term memory and to construct new knowledge, Information and Communication Technology (ICT) plays very important, crucial, essential and key role. So, immense importance should be given to the ICT selection during instructional design model making. In present study also ICT based constructivism model of 5E teaching is used.

1.4 CONSTRUCTIVIST APPROACH BASED ON 5E MODEL

To construct a new knowledge the individual’s prior knowledge, prior experiences, believes, environmental factors both extraneous and intrinsic, economic background, socio cultural background, developmental level, etc. plays a crucial role.

To construct new knowledge first step required for the same is to get answer of how and why of information and second is to relate pre and existing knowledge. Construction of knowledge is very active phenomenon, which gets constructed in the mind of the learner. Theories of Constructivism are embedded in the ICT mediated instructions. Driscoll (1994) articulated a clear framework of five principles of constructivist learning, such as:

i. Integration of appropriate learning activities
ii. Inculcation of collaborative learning environment
iii. Emphasis on representation of content in multiple forms
iv. Instructions as per students’ interest and need
The learning of an individual and to construct new knowledge is very much dependent on individual’s prior belief, knowledge and experience. It is generalized fact, that prior notions, believes and concept plays very important element of learning. Constructivism is a learning strategy that draws on students’ existing knowledge, beliefs, and skills. With a constructivist approach, students synthesize new understanding from prior learning and new information.

Constructivism model of 5E learning is very much effective, operative and functional for science education as it is blended with the existing theories of learning. Moreover 5E Model is based on the Constructivist Approach so very much useful for teaching of science subject. This model was developed during the BSCS (Biological Science Curriculum Study) Project. For secondary science teaching this model was initially constructed by the science educators. Trowbridge and Bybee (1990) envisioned five-phase model in which learners begin to investigate phenomenon and eventually complete the learning cycle by creating conceptions, theories and generalizations based on their work. This model provides opportunities to learner to learn science easily and quickly. The five phases, of which titles capture the essence of the students’ actions, are listed as follows:

1 Engagement 2 Exploration 3 Explanation 4 Elaboration 5 Evaluation given in Fig.1.2:

FIG. 1.2: 5E MODEL AND ITS PHASES
The 5 E's is an instructional model based on the constructivist approach to learning, explores that learners build or construct new ideas on top of their old ideas. The 5 E's can be used with students of all ages, including adults. The philosophy about learning, that proposes learners need to build their own understanding of new ideas, has been labeled constructivism. Much has been researched and written by many eminent leaders in the fields of learning theory and cognition. Scholars such as Jean Piaget, Eleanor Duckworth, George Hein, and Howard Gardener have explored these ideas in-depth. Each of the 5 E's describes a phase of learning, and each phase begins with the letter "E": Engage, Explore, Explain, Elaborate, and Evaluate. The 5 E's allows students and teachers to experience common activities, to use and build on prior knowledge and experience, to construct meaning, and to continually assess their knowledge and understanding of a concept.

The Five Es is a teaching model, based on Piagetian theory, which can be used to implement constructivism in teaching and learning process. Teacher must use constructivist approach while designing a lesson to make it interesting, motivating and encourage the students for developing higher-order thinking. Use of 5E approach is helpful for teacher as well as it promote experiential learning.

I. Engagement: Engage Phase

The Engagement phase is the attempt to activate prior knowledge to discover student preconceptions. Prior knowledge is the major factor in understanding in any subject. The lesson mentally engages with question and activities, construction of new things through their previous knowledge as the base. This will focus student’s attention, stimulate their thinking and access their prior knowledge. The activities under this stage should enable learners to make connection between past and present learning experiences and organize their experiences.

Engagement of the students in the class can be done via conducting some activity, asking questions, demonstration etc. Instructor establishes rules and regulations as well as the activities to be performed to engage the students. The engagement of the students should be like that through which they should feel motivated, interested, excited and actively engaged physically as well as mentally. The successful learning will take place only if the teacher gives hands on experience to the students.
It is synthesized by educators and educational researchers, that when students are highly engaged in performing science pertaining activities or learning science then they build new knowledge in an excellent way.

II. Exploration

When the students are engaged or had shown the interest in ideas, the next phase which starts is exploration. For exploration that activities should be designed which are common and those experiences should be given which are concrete. Basically, those activities, which initiate the construction of concept. The activities which gives students time to think and investigate, test, make decisions, solve problem, collect information, perform, investigate, collect information from authentic resources, construct a model etc. should be assigned. The teacher acts as a facilitator in the exploration phase.

To get involved with the material, process and phenomenon students need to be given an opportunity to work together in teams, share the ideas for the process, share common experiences to explore. Teacher should act as a facilitator and guide and should supply the material and resources. Student’s inquiry should be tackled carefully to nurture their hidden talent.

III. Explanation:

In explanation stage the learners communicates the idea or concept i.e. abstract experiences are communicated step by step with some logics or interlinks. The experiences are shared and explained with the facilitator, peers etc. When the task is assigned to the group, the learners support each other’s explained experiences, ideas and motivate each other to explain further to reach a particular ideas, hypotheses, questions or observation or conclusion.

There are some activities which allow learners to examine the exploration regarding task performed by them. Understanding of students’ is clarified only, when they reflect. Students also analyze and explain during exploration phase.

In the explanation phase the ideas or experiences for explanation are gathered from both printed and non printed media and also from teacher. The varied ways via which explanation can be done are oral presentation, video mode, film, animation, reading and with the help of demonstration.
In science when the students construct their knowledge they use some scientific words for explanation and at the end they will use some scientific terms to explain experiences and will develop and expand the concepts, processes and skills.

IV. Elaboration

In this stage the students will develop the concepts based on which they have taught. They will make associations with other concepts, and apply their understandings to their general surroundings. Applications to real world occasions, for example, where to plant blossoms so they get daylight the vast majority of the day, or how to prop up a shoreline umbrella for shade from the Sun, are both expansions and applications of the idea that light goes in a straight way. These associations frequently prompt further request and new understandings.

Exercises for elaboration can grow and solidify students’ thinking as they apply it to a certifiable circumstance, critical thinking, choice making, exploratory request, thinking ability exercises look at, arrange/apply etc. Once students start creating a clarification of their remaining assignments, it is vital to include students in further encounters that amplify or clear up the ideas, techniques, or abilities. The word clarification implies the demonstration in which ideas, methods, or abilities become simple, conceivable and clear. The methodology of clarification gives the understudies and instructor with a typical utilization of terms in respect to the learning errand. At times, understudies may at present have confusions, or they might just comprehend an idea regarding the exploratory experience. Elaboration exercises give students further time and encounters that help learning.

V. Evaluation:

Evaluate phase comprises an on-going diagnostic process that permits the instructor to figure out whether the learner has achieved understanding of ideas and learning. Evaluation and assessment can happen at all focuses along the continuum of the instructional methodology. A portion of the apparatuses that support in this demonstrative procedure are: rubrics (evaluated and prioritized conclusion desires)
decided as an inseparable unit with the lesson plan, instructor perception organized by agendas, understudy meetings, portfolios composed with particular purposes, task and issue based learning items, and inserted evaluations. Solidify proof of the learning move ahead is most important in correspondences between students, instructors, parents and administrators.

Showcases of fulfillment and advancement upgrade, understanding for all gatherings included in the instructive process, further it can get to be bouncing off focuses for extra perfection of the students' instruction. These confirmations of learning serve to guide the educator in further lesson arranging and may flag the requirement for change and alter. Case in point, if an educator sees clear proof of misinterpretation, then he/she can return to the idea to upgrade clearer understanding. On the off chance that the understudies show significant enthusiasm toward an expanding bearing of request, the instructor can consider refocusing the examination to exploit this abnormal state of investment. Exercises which permit the educator to survey student execution and/or understandings of ideas, aptitudes, procedures, and applications, any of the past exercises, create a scoring guide or rubric, performance assessment, produce a product, journal entry, portfolio etc.

The 5e instructional model is adjusted to numerous procedures included in investigative request. In science, the techniques for scientific inquiry are a phenomenal means for students to assess their clarifications. These routines are, when its all said and done, harmonious with science. At the point when the subject is taught as per 5e Model, understudies use mechanical supplies all the more viably. Utilizing machine, web and other innovative gears of understudies expands the adequacy of this methodology. In the execution of 5e Model, Computers and machine supported projects have been utilized. It is presumed that utilizing machine is extremely compelling for helping understudies to comprehend the subject all the more impeccably. Uses of computer in the learning environment help the students to achieve their objectives all the more early and effortlessly.
Scientific inquiry is an excellent method to evaluate explanation made by science students and when 5E instructional model is used, the scientific inquiry method gets most suitably fixed in it as this method is, after all, congruent with science. ICT based tools and services can be utilized most effectively in 5E Model based approach. Uses of computer in the learning environment help the students to attain their goals more early and easily.

1.5 DETERMINANTS OF EFFECTIVENESS OF INSTRUCTION

The effectiveness of instruction and performance of the students is influenced by a large number of factors: the planning of instruction, the type of instructional system, the instructional media used for instruction, physical facilities of the school, attitudes of the students, and to a large extent, the intelligence level of the learners. For the present study, the factors namely, physical facilities of the school, level of intelligence and attitudes of the students toward instructional media, are considered as the variable for determining the potential of Information and communication technology as an instructional media, used in instructional system of teaching-learning process. An effective instruction requires careful planning.

1.5.1 Instructional System

Instructional system may be viewed as a sequence and arrangement of external conditions of learning, in such a way that will optimally interact with the internal capacities of the learners, so as to bring about a chance in their capacities (Gagne, 1965). As instruction also shares all the features of a system, so it may be taken as a sub-system of an educational system. Hannum and Briggs (1982) investigated that instructional system may be viewed as composed of various inter-related components functioning together to achieve a purpose.

1.5.2 Task Description

"Task" is a "partially defined term" standing for any group of activities performed at about the same time, or in a close sequence, and sharing a common work objective (Miller, 1962). Task description highlights how a task is performed in a referent system. On content aspect, it helps in discriminating, the essential information from unnecessary information. On method aspect, the task description helps in
identification of the types of learning, and their order to realize instructional objectives. For objectives to be useful in instructional design, Mager (1962) suggested three conditions:

(a) Specification of the kind of behavior, which is acceptable as evidence of successful instruction.
(b) Statement of the conditions under which behavior is to occur.
(c) Specification of performance standards, usually specification of acceptable accuracy and speed.

1.5.3 Characteristics of Learners

The characteristics with which a child enters a classroom have tremendous bearing on his performance in the classroom. Some people learn the task faster than the others. Such differences in performance may be attributed to their intelligence, attitudes and variations in their past learning. Study habits and attitudes towards studies (Rao 1965; Jain 1967), ability and academic motivation (Singh 1965), class adjustment (Jha 1970), academic achievement (Rai 1974), interest in the subject (Lalithama 1975) etc., that the learners bring with them to instructional situation, are powerful determinants of the potential success of the instruction.

1.5.4 Learning Types

Appropriate sequencing of learning task has long been assumed to be an important variable in the presentation of instructional material. Ausubel (1963) has contended that "of all the possible conditions that affect cognitive structure, it is self-significant that none can be more significant than the intent logic and organization of the material". Content sequencing is fundamental to any intended learning situation. In fact, sequencing refers to the design decisions pertaining to the order in which subject matter is presented. The basic reason for sequences of instruction is simply that the desired learning cannot take place all at once, therefore, must be designed so as to occur in a series of steps, or in a succession of individual occasions (Gagne and Briggs, 1973).

1.5.5 Instructional Strategy

Instructional strategy refers to a planned sequence of instructional events/activities, designed to attain instructional goals. The research evidence indicated a number of factors which are associated with better performance in different aspects of
learner's capabilities. Austin (1975) indicated that competency based instructional approach generated more interest of students than did the traditional approach. Gagne (1977) in his comprehensive model for guiding learning suggested that pre-requisites for learning are connected in a hierarchical fashion. For effective instruction, learning task should be carefully sequenced. Clarke (1978) indicated that repetition variable is most critical in incident learning. Illustration variable is also significant, but cognitive variable appeared to be an interference factor.

Thompson (1980) deliberated that mastery learning strategy as highly favorable instructional component for enhancing student learning and feedback or corrective measures of prime importance. Mastery learning showed a strong relationship with participation, Cues, reinforcement and feedback. Aiello (1981) conducted meta-analysis of 115 studies comparing individualized instruction with traditional instruction and found that, in science, the former approach was more effective. Teaching is more effective when active student-participation is incorporated in the instructional method was concluded by Pratton's (1982). Zakari (1982) found that question led to greater increase in learning than the students receiving only behavioural objectives. However, a combination of these two variables resulted in more learning than either of these variables alone.

1.5.6 Instructional Media

Instructional media are the human and non-human resoucess, material or methodologies used by teachers to overcome all learning problems, including noise factors. The use of instructional media enables teachers to explain, illustrate, disseminate and deliver their lectures more easily and effectively than when they depend on words only (Hindle, 1998). Heinich, Molenda, Russel and Smaldino (2002) stated that, “properly designed instructional media can enhance and promote learning and support teacher-based instructions”. Although, it is generally accepted that media adds to the effectiveness of instruction yet it does so only when:

(i) Aids are selected, keeping in view the characteristics of learners and the learning tasks.

(ii) It is properly used and integrated into the total instructional system.
The main claims of educational media are (i) higher learning outcomes (ii) lesser time for equal level of learning and (iii) more interest generated as compared to conventional instruction with the use of media.

1.5.7 Supporting Measures and Devices

Home assignment – Homework is an important component of an instructional system. Strang (1968, 1975) observed that some homework is essential and it should be a logical extension of class work, enriching the student's knowledge of ideas taught in the classroom. It was further contended that assignment should be tailored to the individual needs and interests of the students, and they should not be too long.

1.5.8 Evaluation and Feedback

Any scientifically designed instructional strategy requires two types of evaluation. First, it demands continuous on-going formative evaluation to provide information, useful for directing students study and instructional programme. Second, an effective strategy also requires summative or end-of-instruction evaluation, primarily to grade student achievement, that provides information about how students have changed with respect to the course objectives. Stano (1981) reported that feedback and corrective procedures enhance learning. Briggs (1982), on the basis of research evidence stressed that instructional revision based on formative evaluation increases instructional effectiveness.

1.6 INDIVIDUALIZED INSTRUCTIONAL SYSTEM

At present, array of more sophisticated learning systems have been created. Some systems care for individual differences mainly by providing remedial work for slower learners and enrichment activities for faster ones, as found in the system based on modular teaching approach, developed for experimental schools (Soedijarto, 1976). Many other systems depend on the principle of acceleration rather than remediation and enrichment. With acceleration there is a single track of learning content that all students follow. However, the faster learners proceed ahead of their average and slower classmates, so that nearly all of the students are at different points along the learning track, each progressing at their own speed.
1.6.1 Instructional Media Selection

The teacher has to select the most appropriate medium through which he is to provide the instructions. An analytical approach to media selection is to analyze the objectives, the learner, and the learning environment, and ask what media attributes are needed and later, the media that provides these attributes, can be identified.

1.6.2 Sensory Modality

Many people recognize that each person has a different learning style and technique. Everyone has a mix of learning styles. Some people may find that they have a dominant style of learning, with far less use of the other styles. Others may find that they use different styles in different circumstances. Any classroom would include a mix of students who have a variety of learning styles; further no two students are alike; as they have different backgrounds, strengths and weaknesses, interests, ambitions, senses of responsibility, levels of motivation, and approaches to studying.

Learning style refers to how an individual "absorbs" information. Information can only be absorbed using one's senses. People can learn through more than one sense but at times single sensory mode is predominant. Effective matching between teaching and learning style at both teacher and student end respectively can only be achieved when teachers are aware of the students’ learning style preferences. It is a type of physical phenomenon that can be sensed. Examples are temperature, taste, sound, and pressure. The type of sensory receptor activated by a stimulus plays the primary role in coding the stimulus modality.

1.6.3 Symbolic Modality and Symbol System

The modal symbols are the image-based analog representations of the perceptual experience. Symbol systems are “structures of appearance” that determine how the knowledge domain is expressed by the medium. When the pictures, images, text, and algebraic notations are set together with some rules or prescribed conventions and result into a particular knowledge domain is called as a symbol. Different symbols are formed for different information as they have specific meaning and co relation with the desired information. Symbols are also made to perform certain tasks.
1.6.4 Design Cues and Codes

There are numerous ways to present content. Basically there are two ways to convey cues that are verbal and non-verbal and both are very much essential and desirable in the classroom processes. It can be in the forms of images, graphs, video, facial expressions, body gestures, tone of voice, appearance, proximity, eye contact, looking direction, dress, etc. All cues have much involvement and influence for social communication. Social presence is thought to affect learner satisfaction, motivation, and cognitive gain. Various forms of presenting content, via computer, differ in the number and quality of visual and verbal cues that they can convey. For example, full-motion video contains more verbal and non-verbal messages than text displays.

Meringoff (1980) found that children seeing a film recalled more action content than those who read a comparable picture book. Hence, the mere absence or presence of cue does not make any impact. It is how the cue is used that matters.

1.6.5 Locus of Control Characteristics

Locus of control attributes concerns the degree to which users of instructional materials can control their access to information. Motion picture and audio-tapes are fixed in pace and sequence allowing learners little control. Print materials may allow maximum learner control. In Computer Assisted Instruction (CAI), the learner is usually allowed to control the pace of instruction, frequently allowed to control some aspects of the sequence of instruction and in rare cases given the choice of instructional goals. Thus, providing for individualization in rate of instruction seems generally advisable especially when learner population is heterogeneous.

1.6.6 Interactive Features

Information and Communication technology is taking dramatic advances in the potential for learner-programme interaction. Analyzing instructional media in terms of media attributes clarifies how media can be effectively used to provide the information and when these media activate the mental operations that are necessary for learning to occur. Matching the instructions to aptitudes and abilities of learners has frustrated educators for years. The frustration arose because divergent group of learners seem to be present in the classroom. The first group learns a new concept and idea quickly, once exposed to a new thought or idea and gets ready to proceed with independent work. The
second group does not learn new concept and idea so quickly this group needs more teacher-help to learn new concept and idea. The result is that, in a classroom of learners with such mixed aptitudes and abilities, the first group of learners is often held back from additional learning until the second group of the class is able to grasp and pick up the concept or idea being taught because the teacher, teaching in the classroom, is unable to be in more than one place at a time. In other words, the teacher is unable to handle two different and divergent group of the same classroom at one time.

Therefore, it could be concluded that, the teacher in such situations spends time with one group at the expense of the other. Information and Communication Technology can tackle this situation and can provide the solution for a teacher to meet the needs of several divergent groups of aptitudes and abilities in a classroom simultaneously, without at the expense of any one group. With Information and Communication Technology, learners can learn at their own speed and also according to their own abilities and aptitudes. The teacher, at the same time, as a manager and facilitator of knowledge, can be more efficient and effective.

1.7 INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) AND ITS CONTRIBUTIONS

Information and communication technology (ICT) enabled teaching-learning encompasses array of techniques, tools, content and resources aimed at perking up the eminence and efficiency of the teaching-learning process. Ranging from projecting media to support a lesson, to multimedia self-learning modules, to simulations to virtual learning environments, there are variety of choices accessible to the science teacher to employ assorted modes to employ ICT tools and resources for effective pedagogy. With the introduction of ICT in the science classroom, the confronts to science learning are larger especially to inculcate scientific skills, knowledge, and application as it can provide an environment for learning that is self paced, learner controlled and oozes dynamism.

In the 1970s computer was first time used in schools with this the entry of computer in education took place. With the advent of computer in education other accessories or digital media like printers, scanners, digital cameras and floppy disks
came into existence. When with computer other peripheral devices were connected the term Information Technology (IT) was used for the same. With the passage of time computer network, internet, World Wide Web (WWW), email and search engines began to be used for communication the new term Information and Communication Technology (ICT) conceived. ICT actually embraces varied technologies that enable us to receive, communicate or exchange information with others. Varied ICT based tools and services are mentioned in figure 1.3

Varied forms of technology utilized for creation, storage, processing, exchange and transmission and presentation of information (voice, data, text, images of information) are called Information and communication technologies (ICTs). Moreover ICT includes technologies namely, radio, television, video, DVD, telephone (both fixed line and mobile phones), satellite systems, computer, network, hardware and software, as well as the equipment and services associated and rendered by these, such as electronic mail, search engine and videoconferencing (UNESCO, 2002).

ICTs can be divided into two components namely Information and Communication Infrastructure (ICI) and Information Technology (IT) Information and Communication Infrastructure (ICI) is concerned with physical telecommunications systems and networks (cellular, broadcast, cable, satellite, postal) and the services that utilize those (Internet, voice, mail, radio, and television. Information Technology (IT) comprises the hardware and software of information collection, storage, processing, and presentation (World Bank, 2002).

Massive and varied type of information signals hum in the air we are breathing. These information signals are sensed, directed, shared, exchanged, stored and interpreted via information and Communication Technologies (ICTs). ICT is an umbrella term comprises a full gamut of ICT tools, resources and services, basically, ICT perceive varied type of signals.

Enormous impact of ICT is seen on society. “A third revolution” is how UNESCO (2005) describes their impact in a more than 200 pages report namely Towards Knowledge Societies (TKS). ICT has transformed the contemporary world, it seems very much impossible to function or endure without ICT.
FIG 1.3: ICT COMPRISING TECHNOLOGIES (Source: UNESCO (2010)
ICT Transforming Education: A Regional Guide)
Now a days the popular image of young people – the ‘screenagers’ referred by Rushkoff (1997) forms a ‘digital generation’ those are squarely occupied by technology and are emerging as totally technology dependent society, connected by sophisticated telecommunication networks like smart mobile phones, palm top, tablets laptop, television, computer etc.

Each year the world’s store of information almost doubles that of the year before. A global market intelligence company reports that by 2011 the digital universe is 10 times the size it was in 2006. The situation is described as an exploding digital universe (IDC, 2008).

Due to massive explosion of information and knowledge world has collapsed into a small village, the credit for this change goes exclusively to ICT. Approximately more than 7,000 articles both scientific and technical are published on daily basis (Resta and Patru, 2010). There is massive increase in the number of known substances, earlier the known substances number was 1800 and now approximately 25 million substances are known by chemists. Today knowledge and information is alleged as novel form of wealth which is acting as powerful force for improvement and development. Exceptionally high speed ICT based tools are functioning as a driving force for all this changes i.e. expansion of knowledge and information.

There have been tremendous advances in technology and innovative stuffs are discovered each day. The pioneering impact of ICT is on education system i.e. in administration, management and teaching learning process.

Globalization and technological changes have created a new global economy powered by technology, fueled by information and driven by knowledge.” Educational institutions have to produce that type of products which can deal with the new emerging global economy. The knowledge can not be imparted now for a fixed period of time as the access of information is growing rapidly and we have to make the new generation compatible with this information age by fully equipping them with ICT to ace the modern word.

Information and communication technologies (ICTs) like radio, Mobile phones, television, computers, internet etc. are of mammoth importance to bring the change and transform the education. When we have to make students learn the active process, the
necessity arises that we have to integrate ICT aptly to help the students to access the education by different ways and means basically by modifying and revamping the teaching learning process.

When information and communication technologies (ICTs) are smeared with education, it is designated as ICT in education. Earlier, terminology labeled for technology in education was Educational technology, this terminology was used because both hardware and software approaches were employed to achieve the desired learning outcomes. In this technology prone era the term ICT is used as word communication introduced. So it becomes imperative to focuses on the ICT based infrastructure, devices and sources to be implemented in education system.

1.7.1 ICT in Education: Retrospect

In the year 1937 a regular broadcast for school children was started from Calcutta Station of All India Radio (AIR). At present 40 stations are producing and 30 stations are relaying these programmes. From these programmes teachers as well school children of different classes are getting benefit. Other than prescribed curriculum based programme the other programmes like Teach English and Learn English (TELE) is also broadcasted. Radio has been used to broadcast the programmes for adults as well as for under-graduate students.

Teaching aids usage was emphasized in India in the year 1940 and 1950 further in the 1960s and 1970s there was emphasis to use Programmed Learning Material (PLM). under the Secretariat Advent of INSAT The Government of India launched an ambitious project “Indian National Satellite System” in 1982 and decided to substantial improve the educational condition in the country by utilizing new communication and information facilities provided by this system, INSAT. The Educational Technology Division in the Ministry of Education and Culture designed a project INSAT for EDUCATION covering the establishment of a Central Institute of Educational Technology (CIET) at New Delhi and State Institute of Educational Technology (SIETs) in all States. The CIET would provide the organisation framework, production capacity and training facilities to assist the SIETs develop and produce Educational TV Programmes relevant to the need and conditions of the target audience telecast via INSAT and appropriate support materials in their regions.
In the beginning, programmes produced by SIETs were telecasted by INSAT and appropriate support and utilization components were provided by the SIETs in collaboration with the CIET. It was decided initially to establish SIETs in the six Pradeshs, Orissa, Maharashtra, Gujarat, Uttar Pradesh and Bihar covered has provided substantial financial input to establish the SIET under INSAT for Education Project. The UGC sponsored programme namely Country Wide Classroom for the undergraduates was started on 15 Aug. 1984.

Educational Technology flourished in this country as a centrally sponsored scheme and various kinds of facilities like colour TV sets, sponsored Players (RCCP), VCR, V CP etc., were provided to different schools. The six autonomous SIETs in Uttar Pradesh, Wlhar, Orissa, Maharashtra, Gujarat and Andhra Pradesh were funded by the Central Government., and more financial support was extended to the CIET, NCERT for producing programmes for the schools for telecasting/broadcasting through Doordarsan/Akash Vani. CIETs and SIETs were funded under the scheme for producing ETV and radio programmes for education. The Educational Technology programmes tried to bring about qualitative improvement and widening the access to education. By 1999-2000 approximately 3,92,438 RCCP and 75,001 colour TV sets were provided to the States and Union Territories for primary and upper-primary schools. CIET and SIETs produced as many as 683 video and audio programmes. The importance of educational technology and its expansion is increasing with every passing day.

i. Contribution of Educational Radio

Education pertaining to school, social, university, women etc. both in formal and non formal way via radio has been imparted in India since the year 1929. IGNOU is playing pioneer role in making the availability of education radio programmes. It can provide valuable assistance to the teacher in the classroom by presenting worth while information and learning experiences to a large number of students. Via educational radio teaching possibilities are available from early morning till long after midnight.

ii. Contribution of Educational Television

Like most of the advanced developing countries of the world, India has also started to use TV in education for improving the quality of education. Teacher may
learn the skill and art of his profession by observing the TV programmes. Television based instructions have the potentiality of improving the process and products of learning. Television can display the world of reality in the classroom. It may offer some solution for the problems of shortage in education: shortage of good teachers, classrooms, audio-visual aids and other resources. Both UGC and IGNOU have ETV broadcast for different leveled courses.

An exclusive channel DD Gyan Darshan dedicated for education at different levels is made operational round the clock. There are 24 hour satellite channel D D Bharti which were launched on January 26, 2002 for Door Darshan viewers.

iii. Computers in Education

The idea of using computer as an educational tool for the first time bloomed in the United States. It was the time when programmed instruction was taken up as a most reliable teaching strategy. However, in India some technology savvy private schools are passing through this transition phase now and some experimentation is taking place at that level though it is not widespread. The computer is no longer a subject of study or mere supplement to an existing curriculum. It is gaining space as an integral part of the schooling process.

Use of computer in education creates a new environment in schools and facilitates the students in acquiring skills that enhance their effectiveness in life. Computer as an educational aid is used to improve learners' skills in academic subjects at different levels of education. It helps children to become less dependent on the teachers as experts. The use of computer encourages cooperation as against cutthroat competition among children in the learning process.

Some of the private schools in major cities in India already have computer education from class 1 onwards, in which emphasis is laid more on computer as a medium than computer as a subject. The government has also decided to provide ICT infrastructure in all schools. A modest beginning in this direction has already been made.
1.7.2 Characteristics of ICT in Education

ICT has been developing very rapidly nowadays. Education has been influenced by a number of factors today. Some of the important factors are:

I. shift from knowledge replication and repetition to knowledge generation and construction,

II. making students take responsibility for their learning emphasizing motivation,

III. changing role of teachers from transmitters of knowledge to facilitators and supporters of learning,

IV. moving away from teacher-centered to learner-centered education,

V. shifting linear view of learning to networked view of learning,

VI. giving importance from mind to heart and

VII. belief that learning could take place Outside classrooms and the walls of the school.

All these changing factors require innovation in teaching-learning process. This innovation or intervention, takes the form of Information and Communication Technology. Therefore the whole educational system should be reformed and ICT should be integrated into educational activities. Alone ICT can not bring change. Teacher can be regarded as an active element to bring the change as she can act as a catalyst for establishing ICT dominated culture. A new culture of teaching has to be developed which should be squarely occupied by the ICTs. Hence, all the educational institutions, policy planners, administrators and especially teacher educators must pay special attention to this aspect.

1.7.3 Need of Using ICT in Education

For the effectiveness and efficacy of education in both formal and non formal way it is very much essential to use ICT. ICT can be used for:
a) To share and broadcast the course contents or resources of different subjects via online or CD-ROM
b) For communication purpose with pupils individually or in groups, peers or with students of special need.
c) To develop psycho-motor control and space regarding awareness with the use of electronic toys.
d) For collaborative learning and sharing information via usage of online resources like email, chat, discussion forum etc.
e) For the involvement of large number of students from distant geographic areas via video-conferencing or other form of teleconferencing.
f) For combining varied technologies and methods in the teaching learning i.e basically for Blended learning.
g) For the assessment and evaluation processes
h) For administrative processes at varied levels
i) For research purposes by exploring internet to transform educational processes

1.7.4 Advantages of the use of ICT in Education

ICTs are a potentially powerful tool for extending educational opportunities in formal as well as non-formal system of education. ICTs based technologies render services in the form videoconferencing, teleconferencing, e-learning and satellite based education. One of the most commonly cited reasons for using ICTs in the classroom have been to prepare the current generation to get adjusted in the modern world. In classroom ICT can be used for making assignments, collecting data and documentation communicating and conducting research. The potential of ICT's to promote the acquisition of the skills, to use a tool for raising educational quality and promoting the learner-centered environment.

ICT's can enhance the quality of education in several ways like preparing for the 'Real world', fostering inquiry and exploration and enhancing the quality of teaching, it also enhance, the other aspects in education process as follows:

(i). Active learning: learners are found to be very much dynamic and vigorous in the ICT based learning environment as it assembles tools for examination and analysis of
information, thus providing a platform for student inquiry, and construction of new information. It promotes increased learner engagement.

(ii). \textbf{Facilitating for the acquisition of basic skills:} it is a well known and proven fact that, for creativity and higher order thinking skills that type of opportunities are to be created where the students first acquire basic skills. These can be facilitated by ICT. Further the learners can be trained to acquire the skills via drill and practice.

(iii). \textbf{Motivating to learn:} ICT based learning environment makes the students to be remain engaged and motivated for learning. Underneath examples explores about the same:

- Usage of ICT mediated instructions comprising multi media linked with computer, video lesson, television, animated images and sound can be inserted in the text to make the learning more interactive and students will be engaged in class and more learning will take place.

- As interactivity is increasing with computer based education same way interactive radio usage with lots of sound effects, songs, dramatizations, and comic skills and other performance conventions to compel the students to listen and become involved in the lessons being delivered.

- Computers networked with internet to get connected with real world via video conferencing, virtual learning synchronous and asynchronous mode of leaning, mobile learning, e-learning etc. will motivate the learners.

(iv). \textbf{Anytime, anywhere:} both synchronous and asynchronous form of learning is made possible by ICTs, for example teleconferencing technologies enabled instruction to be received simultaneously by multiple, geographically dispersed learners (i.e., synchronous learning). Any time anywhere accessibility of course material, learning material, demonstration, information, instructions, interaction bet learners, learner and teachers, learner and experts etc. is made possible by ICT only. Varied type of ICT tools like TV, Radio, satellite, Internet etc. is used for imparting instructions.

(v). \textbf{Access to remote learning resources:} gone are the days when only on printed books and other materials in physical media housed in libraries were used by the students and teachers, for their educational needs. With the advent of Internet and the
world wide web, a wealth of learning materials, in almost every subject and in a variety of media can now be accessed from anywhere at anytime of the day and by an unlimited number of people. This is significant for many schools in developing countries; the remote area learners are also benefitted for any time learning.

(vi). Collaborative learning: ICT-supported learning encourages interaction and co-operation among students, teachers and experts. It provides learners the opportunity to work with people from different cultures, thereby helping to enhance culture, learner’s team building and communicative skills as well as their global awareness.

(vii). For Creative learning: Received information is manipulated and products for real world utilization which are very much innovative, interactive and above all creative are made possible via ICT. As learning supported with ICT promotes for the same.

(viii). Integrative learning: ICT enabled learning promotes the integrated approach of learning. The link is made between varied disciplines by crossing the confined limit of the subject which is taught in water tight compartments. The integrated approach opens the new ways for innovation and research.

(ix). Evaluative learning: ICT-enhanced learning is student directed and diagnostic. It allows learners to explore and discover rather than merely listen and remember.

(x). Enhancing teacher training: ICT has made possible to train the teachers in that type of environment where we can produce excellent teachers by providing then excellent opportunities of training.

Information and Communication Technology is uniquely placed to generate the Quality in education. The full benefit a technology in the educational process is realized only by enhancing the technology skill of faculty and students, Available resources can be utilized and implemented in the research work to promote the team-work global consciousness, self-paced learning, problem solving and cognitive process. Research has shown that the appropriate use of ICTs can catalyze the paradigmatic shift in both content and pedagogy that is at the heart education reform in the 21st Century. ICT-
supported education can promote the acquisition of knowledge and skill that will empower students for life long learning.

1.7.5 Factors associated with Facilitating and affecting ICT learning

Usage of ICTs in the educational processes is considered as cult in this age. On the basis of introduction and usage of ICTs like Computers, internet, educational software, laptops and PDAs etc. the status of an organization is assessed up to what extent it is in line with the modern life. Usage of ICTs and its importance in the field of education was strongly recommended over the years. ICTs in education is still in emerging process the rate at which the ICTs are evolving and its usage is just as the tip of an iceberg there are many concerns, problems, difficulties and barriers for its less and inefficient usage. There are varied factors which are responsible for facilitating learning and one of the major factors considered for the same is ICTs, some of the factors are:

A. Factors pertaining to facilitating ICT learning

I. Objectives and goals regarding pedagogy

Different type of goals, objectives aims and outcomes are designed to transform the society and finally these goals should be visible and resonated with the national or state curricula. For the reformed vision of teaching and learning and achieve the desirable pedagogical learning outcomes and get sustainable change in the classrooms it is essential to use ICT as it is a fundamental step. Indian education system is still rooted with the traditional system of teaching so to achieve the pedagogical objectives and goals ICTs is must in the teaching learning process.

II. Leadership

Leadership also plays a vital role at various levels if a new project is to be culminated in an innovative form and design. Basically leadership in schools exists at two levels one is at state or national level as all the policy matters, examination system, curricula, guidelines etc. are prescribed by the state. Second level of leadership is carried out by school administrative authorities for decision making, addressing the problems pertaining to national leadership and usage of technology for administration can be considered as very high lightening projects. Kozma (2005) and Hepp et al. (2004)
evocated that leadership plays a very important role as the school’s leadership is the important connection for bringing the broad, abstract vision into a practical form.

To be a protagonist in the use of ICTs the major role is to be played by the school principals, the leaders of the ICT initiators and teachers. ICT initiators should take the initiatives to train and guide the teachers how to use ICT effectively in the classroom processes. Principals of the schools should provide the all possible ICT related resources and infrastructure, moreover administration regarding managing as well as quality assurance of all ICT based tools and services, further has to ensure about the proper usage of ICT. Whatever the challenges are faced regarding ICT usage and management ha to be taken care by the school principal.

III. Professional development and ongoing support

It is an hour need to fill the gap between the traditional way of imparting instruction and instruction imparted with ICTs the faculty members should be trained. Particularly as a whole reform of the education system is desirable and it is possible via innovations and on going professional development of faculty members. It is very much demanded that to train the faculty members to produce technocrats. Both in service and pre-service training of teachers should be such that teachers should prepare unit plans taking into consideration the level, requirement, pace, individual differences and previous knowledge of the students. So ICT based training regarding classroom management, instructional planning, design, evaluation techniques, pedagogies etc. should be provided for effective teaching and learning.

IV. Time

As the ICT infrastructure and resources are to be managed properly in the same way it is required to manage the time properly. Time regarding the ICT usage i.e. time to be reserved for training the teachers to grow professionally for ICT implementation in classroom process and time to be spared for students to learn ICT based environment. So to get the trained faculty members in ICT usage in the classroom and their maximum output to be achieved from the resources every school has to plan some strategies according to time availability and proper management of time.
VI. ICT infrastructure

To have ICT access in the schools it is an accountability of schools to ensure availability of ICT Infrastructure, resources and tools. It is observed that there is limited ICT based resources in the schools and due to minimal availability of resources, so the problem arises in the schools regarding management of teaching, learning administrative processes and insufficient access, as a result of this students can not use ICT during their classes.

Though lots of schemes pertaining to computer education are launched by the state and National govt. still a large gap is seen in availability of resources. Strategies at school level are to be designed to provide the sufficient access of ICT resources to the students as well as teachers. In India lots of urban schools have computer labs but consistent and frequent access to computers is scarce.

VI. Financing and Sustainability

Costs and sustainability of ICT resources is major challenge for the schools. Schools have to generate ICT resources from varied sources and also try to utilize the maximum and control of cost related to ICT usages is also to be considered. For that multiple strategies are to be developed and implemented.

To reform and bring a change in educational process only teachers are not responsible, change is a long-term and incremental process. Effective reform requires sustained investment and support along multiple dimensions of the educational system, including physical and technical infrastructure, human resources, curricular frameworks, standards, and assessments.

B. Factors affecting ICT learning:

I. Barriers posted at teacher level: there are varied teacher level barriers some are:

- There is paucity of time for both training and self study to refresh the knowledge (Fabry and Higgs, 1997)
- Inadequacy of ICT based tools and services for preparing lesson plans (Preston et al., 2000)
- For ICT usage self-confidence is lacking in teachers (Pelgrum, 2001)
- Teachers might have gone through some negative or bad experiences with ICT usage in the past (Snoeyink and Ertmer, 2001)
- Teachers have fear of loss of status and embarrassment in the classroom and in front of the colleagues. Other than that is the fear of degradation of professional skills (Russell and Bradley, 1997)
- While using ICT in the classroom difficulties are faced like management of classroom and there is dearth of ICT resources like computer number and students strength mismatch (Drenoyianni and Selwood, 1998; Cox et al. 1999)
- Teachers do not have knowledge or idea how to tackle the technical problem when it persist in classroom (Van Fossen, 1999)
- Teachers have opinion that to operate computers is a complicated and difficult task (Cox et al. 1999)
- Teachers are not trained to cope with personal management (Cox et al. 1999)
- Most of the teachers have believe that ICT do not bring any change in learning (Yuen and Ma, 2002; Preston et al., 2000)
- Teachers are not motivated to use the innovative pedagogical strategies (Snoeyink and Ertmer, 2001)

II. Barriers posted at school level: school level barriers are as follow:
- ICT resources are inadequate in schools (Pelgrum, 2001 and Guha, 2000) and if available they are deteriorating and not properly managed (Cox et al., 1999)
- Access to ICT resources is lacking and is because of varied factors regarding organization such as ICT resources are not placed in the classrooms or labs (Fabry and Higgs, 1997; Cuban et al. 2001)
- Available software and hardware are not updated (Preston et al., 2000)
- ICT resources are not reliable (Butler and Sellbom, 2002)
- Technical support to manage and handle the ICT resources is missing (Preston et al. 2000; Cox et al. 1999)
- Proper support for the ICT resources at administrative level is missing (Albaugh, 1997; Butler and Sellbom, 2002)
- Change is not supported by leaders, planner and teachers as well as by administrators to implement change is not appreciated (Larner and Timberlake, 1995; Cox et al., 1999)
- Training for teachers as per their potential to use ICT is not existing (Veen, 1993)
• Training to teachers, regarding how to use ICT in the classroom process is not provided (Van Fossen, 1999).

III. Explanation of varied findings

External and Internal are the two basic barriers in ICT usage, sustainability and cost effectiveness. External barriers incorporate scarcity of equipment, non-reliable and lack of technical support, Internal barriers include organizational culture and teacher’s openness to change with technology (Snoeyink and Ertmer, 2001).

As per the international findings scarcity of ICT resources is considered as one of the major obstacles (Pelgrum, 2001). (Guha, 2000) found that the teachers complaint about the lack of required equipment after using technology.

The difficulties and challenges faced at the teachers level like phobia of using the ICT tools and services in the classroom, notions built about usage of ICT from the past experiences, negative attitude towards the ICT, viewpoint about the relevance of ICT to their subject and practical difficulties encountered with ICT in the classroom. Barriers of first order can be concealed by the second order barriers. Like teachers perceive that it is difficult to use computer hardware and software, basically this attitude is due to lack of confidence (Snoeyink and Ertmer, 2001).

When first order barriers get treated the second order barriers emerging at school or policy level associated with teachers will get healed automatically (Mumtaz 2000). So it is the demand of present to train the teachers in ICT equipped environment.

IV. Attitude

Both students and teachers’ attitude towards use of ICT is one of the most important barriers and can be influenced by other barriers. Technophobia acts a major barrier in using ICT in classrooms Technology brings with it, fear and anxiety. Many of the teachers and teacher educators develop a fear that they might spoil the equipment by using it improperly. There are negative or destructive uses of technology too. The students are likely to use it for recreational purpose also. Fabry and Higgs (1997) classified attitudes into three groups one is self-confidence of teachers for the use of ICT, second one is the perception of teachers regarding the
significance and relevance of ICT usage and third one is innovation brought in classroom processes with ICT.

The prior experience mostly affects the teachers’ perception about the usage of ICTs in the teaching learning process. Both good and bad experiences are responsible for generating anxiety for computer use. Anxiety about change and computer anxiety are the major barriers for teachers to use technology in the classroom (Larner and Timberlake 1995). Anxieties leads to confusion and fear of embarrassment while using computers in the classroom process (Russell and Bradley, 1997) and another factor i.e. fear of losing professional status (Fabry and Higgs, 1997) are responsible for changing the attitude of teachers towards usage of ICTs.

V. Training

Training in the area of ICT use can help to overcome barriers whether it is teacher or school leveled, yet many researchers argue that it often fails to do so. As already observed (Guha, 2000; Cox et. al.1999) improper time management and training regarding use of computers are the barriers, research suggests that there are both design and delivery problems, drawbacks and weaknesses in many courses. Training of the teachers regarding computers usage depends upon the both teachers’ experiences and learning style, so training for teachers should be planned accordingly (Veen, 1993).

If training need is not recognized and basic ICT skills are not focused then as a result of this teachers will fail to impart ICT based instructions (Fossen, 1999; Wild 1996) When the teachers are trained in the basic skills of ICT use in the institution it becomes problematic (Murphy and Greenwood, 1998), but the serious problem commences when it is found that when tutors are having very less experience of technology implication in teaching learning process (Simpson et. al. 1999). The major problem also occurs when it is found that there is major gap between the training provided during training session and actual condition where the ICT is to be used (Whetstone and Chellman, 2001). Teachers should be motivated encouraged and stimulated to use as much of ICT in the classrooms as possible during teaching
practice (Murphy and Greenwood, 1998) as for new teachers much experience is required. ICT usage demands a lot of time and planning on part of the teachers. Modern teachers are already overburdened because of the evaluation system being examination oriented. They have to perform several duties apart from regular teaching. This reduces interest in using technology in the classrooms.

1.7.6 The Potential of ICT in Powerful Learning Environments

Research has shown that the appropriate use of ICT can catalyze the paradigmatic shift both in content and pedagogy to fetch reform in the 21st century education system. If, ICT supported environment designed and implemented properly, education can promote both knowledge and skills. When ICTs like computer, internet, satellite etc. are aptly, judiciously and used with precision both students and teachers what has performed earlier is performed in an excellent way. Learning becomes more near and relevant to daily life and solving of daily life problems becomes very tranquil and relaxing for learners. ICT controlled learning also activates the students for inquiry, easy calculation and information analysis resulting in to the transformed learners with in-depth problem solving skill and constructers of innovative information. In comparison to rote learning or memorization ICT controlled learning is more learners centered and have more engagement.

For active learning and higher-order thinking ICT plays a major role (Alexander and Jonassen, 1999). ICT has proven to be a major factor to accelerate co-operative learning and content reflection (Susman, 1998). If we further calculated the potential of ICT it is useful for curriculum differentiation, adoption of learning activities according to learners need, level and also providing them personalized feedback (Mooij, 1999; Smeets and Mooij, 2001). It was made apparent by Stoddart and Niederhauser (1993) that ICT is useful in varied instructional approaches whether it is traditional to innovative approach further it was made clear by Niederhauser and Stoddart (2001) that two type of ICT based soft wares are useful in education one is skill-based and other is open-ended software.

Generation of powerful learning environments depends upon the type of ICTs used (Jonassen and Squires, 1999). It is evocated that in schools more focus is rendered for
use of traditional skill based ICT (Chalkley and Nicholas, 1997; Richardson, 1997; Smeets and Mooij, 2001; Williams, Coles, Wilson, Richardson, and Tuson, 2000).

Harrison et al. (2002) observed a significant relation between the quantity of ICT used and students’ achievement, further it was also reiterated that type of ICT used also plays a vital role in students’ achievement.

A significant impact on learning environment was observed, developed by teachers with the assistance suitable software. So the selection and usage of appropriate ICTs for generating a powerful learning environment is a skillful activity. The accessibility of ICT is also an important aspect which influences the use of ICT (Kennewell, Parkinson, and Tanner, 2000; OTA, 1995). Kennewell et al. (2000) concluded that when computer are placed in the classrooms, only then their optimum utilization for classroom activities is possible.

Basically the availability of ICT resources is of no importance if its utilization does not exist. Teachers’ perception, about change made by ICT and its contribution to the learning environment matters a lot (Drenoyanni and Selwood, 1998; Higgins and Moseley, 2001; Hokanson and Hooper, 2000; Niederhauser and Stoddart, 2001). It was pointed out by Sinko and Lehtinen (1999) that some standardized principles can not be build regarding learning environment as the variations always persist when implementation of the principles in classrooms persist. Open-ended learning arrangements are required in ICT enabled learning environment as teacher’s role in this environment changes, some time the role of explorer and sometime learner, so, she has to create an intellectual environment in which knowledge is acquired (Hannafin and Savenye, 1993; Keeler, 1996).

In one of the study regarding instruction approach Niederhauser and Stoddart (2001) found that skill based soft wares were supported by those teachers who used traditional approaches of teaching while both skill-based and open-ended soft wares are used by those teachers who appreciated constructivist approach of teaching and learning.

This conclusion was corroborated by Pisapia (1994) that varied type of technology based resources are used by the teachers in exemplary classrooms such as ICT based tools used for drill and practice, exercises, simulations, problem-solving activities and for the evaluation of performed activity.
The most appreciable, extensive and effective use of ICT is observed in the science classrooms and laboratories to combat the problem that students lack interest and feel less motivated for science learning.

1.7.7 ICT in Teaching of Science

With the increase in scientific knowledge, there is an increase in demand for educated students. So there is dire need to develop scientific thinking in young children. Gone are the days when the traditional approach of teaching science was adopted in which, science was viewed considered as body of already discovered knowledge. Teachers were authoritative, areas of study was set by him, large group instruction and investigations was performed, evaluation was based on right answers, content was not connected to children’s experiences, predetermined parameters around areas of study was existing, prescribed ways were there to collect and record data and science was viewed as separate area of the curriculum.

The new approach has released its fang in which science is viewed as active exploration, teacher is viewed as facilitator, areas of study are set by child interest, individual and small group investigations are in style, evaluation is based on multiple criteria, content is connected to children’s experiences, content of study is open-ended, multiple ways are adopted to collect and record data and science is integrated with other curricular areas.

The most extensive uses of ICT in education have been in science at all levels. The science students of present era spend considerable amount of time in using ICTs for leisure time or in school, that is on electronic screens, smart phones and laptops and have become necessities for all the students. Students use electronic gadgets to communicate, message, blog, share, discuss, watch, listen and read volumes of information. Same is the case with science teachers we find that ICT is incorporated in teaching and learning in some or other way. It was not the earlier case it took long duration to make the use of ICT in teaching learning process. More important part of it was that how to make teaching more effective and interesting by the application of ICT in this regard in depth understanding of teaching learning process was more essential and important.
ICT triggered science teaching does not mean only the reversion of traditional teaching but innovative approaches and ways are to adopted to generate inventive and ground breaking ideas. There are 3 major ways in ICT enhanced learning environment through which we can engender new prospects of teaching and learning:

First one is that, science is now in totality shaped and molded by ICT. As science has and technology are significantly related (National curriculum framework, 2005) leading to significant affect on the modern world. It is stated in National curriculum framework that, “Through science, pupils understand how major scientific ideas contribute to technological change – impacting on industry, business and medicine and improving quality of life. Pupils learn to question and discuss science-based issues that may affect their own lives, the direction of society and the future of the world”.

When science and technology work together miracles, wonders and innovations are destined for restructuring and transforming the modern world. The quality of existing lives gets improved as ICT opens the new opportunities. With the assistance of ICT in the teaching learning process varied activities are performed by students like space travel exploring the website of NASA, searching varied information about the existing world, etc. i.e. learners feel remain engaged and motivated. ICT, enable us to produce global scientist who will effect and shape the lives qualitatively.

Second, in science subject the ideas and investigation are assessed practically. Science requires valid evidence to ensure validity of the theories and principles. The main objective of teaching science is to build the critical thinking ability in students to examine the status quo by experimentation. It is authenticated that science generates competence to innovate through analytical and higher order thinking skills. Science produces technocrats, scientists, global researchers etc. for the modern world. It develops the analytical thinking to observe the processes and phenomena and give the accurate meaning to existing phenomena. Pedagogical techniques and strategies are transformed and revamped to promote and enhance scientific attitude. Practical exposure is provided by imparting ICT enabled lab based instructions. With the changing need, varied ICT based tools and resources are exploited and can be used to make teaching more interactive and meaningful. The practical which are strictly restricted to be conducted in the classrooms due to health and safety concerns can be
demonstrated easily with the help of ICT tools like virtual experimentation, power point presentation, animation, video mode etc. as experimentation is the fundamental method of teaching science for making the students understand or investigate any process, phenomenon, principle or theory.

Third, and most essentially, science is all about innovating, creating and bringing the imagination into real world. ICTs have massive potential to enhance and support scientific thinking. ICT has tremendous potential to have interactivity, speed, automate, explore hidden knowledge and innovate. Science is a systematized affluence of knowledge as it bridges a gap between our imagination and reality. It also meshes with all our lives and allows us to channel and use our spontaneous curiosity. With the use of ICT the processes gets simplified to bring accuracy to the results which can’t be imagined through traditional teaching practice. The first question to be considered about the effectiveness of ICT in education is what, if any, impact ICT-mediated instruction has on student performance. For what use is ICT in Science Teaching? It is basically to:

- attract, arouse interest and motivate students.
- increase effectiveness of work in science laboratory.
- encourage the answering of the question: “what will be, if”?
- increase memorization and understanding of knowledge by assuring feedback.
- facilitate realization of the school curricula due to integration of ICT with the contents, to provide application of multimedia methods.
- assure the use of simulations, modelling and investigations in real-time to construct the knowledge of students by their creative individual work.
- cause association of computer-aided work with simplifying of science understanding, as computer helps to solve ordinary as well as complicated problems.
- extend their knowledge beyond the computer resources.

1.7.8 ICT-mediated science instructions

The instruction imparted for science education via varied type of ICT based tools such as computer which is the main platform, television, projectors, internet, radio, television, mobile phones, etc. are known as ICT mediated instructions. It is in two
modes i.e. synchronous and asynchronous. Synchronous means when both teacher and learner are available at the same time for example video conferencing, second mode is asynchronous, with the instructor and student participating at different times, for example simultaneous participation is not required, teaching materials is made available at the web site. In both the ways communication is possible.

1.7.9 ICT based tools and resources in teaching of sciences

ICTs comprise varied tools to be used for science teaching comprising:

- Data computation tools like: spread sheets, database, data collection, processing and computation etc. for graphing, modeling environments etc.
- Multimedia software for simulation of processes and carrying out ‘virtual experiments’
- Information gathering (using Internet browsers and multimedia CD-ROMS)
- Simulations (virtual experiments and visual aids, simulating and helping to explain phenomena) Publishing and presentation tools
- Data handling (using spreadsheets and graphing software to analyse data digital recording
- equipment)
- Use of mathematical models (exploring relationships, predicting and testing theories
- computer projection technology )
- Practical work (using sensors, interfaces and data-logging software)

Theoretical as well as practical concepts of science can be explicated and demonstrated in a simple and very easy way with the help of varied type of ICTs. ICT has numerous potential which can be further enumerated as follows:

- Proper time usage for thinking, exploration, discussion, innovations, relief from cumbersome manual work and more production of work.
- Both school and contemporary sciences are linked together to increase exchange of knowledge and experiences by providing opportunity via ICT to have plethora of access to information.
- More engagement and motivation for science learning.
- Immediate feedback to both theory or lab work accomplished by students
- More focused attention and understanding for abstract phenomenon
ICT enable us to access and utilize large no. of resources and services like Social Networking, Wikis, Bookr, Virtual Worlds, ICT Tutorial, Video Archives, Animations, Entertainment, Web quests, Web2.0s, e-Journals and Bulletins, Graphic Organizers, Resources Education, Science Entertainment Virtual Field Trips, Solar Technologies, Social Bookmarking, Voice Thread, GIS/GPS Virtual Field Trips, Science podcasts, Photo editing, Virtual environments, Concept Maps, Simulations, Space Education, Moodels, Weekly drop and drag blog, Lego Robotics science education blogs, Search Engines, Mobile Phones, Picnik, Science Video Archives, Data Logging, Science Writing, Smart Boards, IWBs, Educational Software for writing scientific reports, Slide Shows and Picture Sharing, Microsoft Updates, Environmental Education Widgets in your Wiki, Pod casting, Concept Maps, Blogs, etc. these tools basically concerned with the imparting qualitative instruction for scientific concepts.

ICT HARDWARE RESOURCES

1. **Laptop computers**

No doubt the laptop computers are expensive but to give the opportunities to the students and teachers to have the ICT supporting system in the classroom teaching its installation is direly demanded. These computers are to be linked with wireless connection to have a full access. These computers can be placed in movable trollies with full charging system on need and requirement these trollies can be placed in the science area when ever and where ever required to perform the science activities in a group or individually. Such type of flexible system can help both teachers and students to get maximum benefits from ICT

2. **Whole class viewing systems**

Whole class viewing system is one of the major options available with us for laboratories and science classrooms.

(a) **Data projectors**

The installation of ICT based devices is a cumbersome activity the only solution to this is installation of ICT based resources like Liquid Crystal Display (LCD) projector in the both laboratories and science classrooms permanently and
further provisions to install more media with the same. With this solution there will be properly managed and effective usage of ICT resources like data projectors.

(b) **Use of video with a projection system**

For effective classroom instruction i.e. to manage the class time properly and to carry on the explanations side by side with presentation the projection system should be permanently installed in the classroom further back plan should also be managed to carry on hassle free classroom instructions. Videos are to be projected with LCD having multi media also installed with the system

3. **Screens and boards:** Underneath screens and boards can be employed for teaching and learning:

(a) **Screens and ordinary whiteboards**

For viewing the images from LCD projector the white boards or screens can be used which are existing in the classrooms. White board can act as a very good option for viewing the projected images. Now days as highly sophisticated and digitized projectors are available, annotated images on the white boards can be zoomed or highlighted for explanation as the projectors with narrow infra-red beam are available. Both teacher and learner can manipulate the images according to his/ her better understanding of the images.

(b) **Interactive whiteboards**

Interactive whiteboards are specially designed boards which are like computer screens and total controlled either with hand i.e. finger pressure or electronic or dummy pens specifically designed for this system. Varied types of soft wares are installed in this board some time note pads are directly installed with the board so that students sitting at their seats in the classroom can get the benefits. These boards can save the various data, lectures and even can repeat the various previous moments existed in the classroom. Different type of interactive whiteboards is available in the market which is with different type of features and inbuilt soft wares.

(c) **Plasma screens**

To view the big images without distortion plasma screens are of the best use, as the screens are large and of flat surface. These screens can be mounted or wall or free
standing moreover these screens are thin and occupies less area. For projection these are connected with LCD projector.

4. **Scan converters**

Scan converters are basically used to feed the data from one PC to several other TV monitors so that several students at a time can view the different images or data. This is the cheapest ICT tool to pass the data to several users. The advantage of this tool is already available equipment can be used for this purpose and the drawbacks noticed from this is the image size which can not be made more bigger than TV monitor size and it is not interactive.

5. **Standard Applications:** Few of the standard applications are given below:

(a) **Electronic worksheets**

For extension to laboratories or classroom activities the teachers can design the worksheets to be used by the students. To make the student active participant it can be used by the individual student or to promote interactivity and remain engaged in the classroom. So worksheets should be well designed to achieve the learning outcomes.

(b) **Microsoft (MS) Word**

Microsoft Word is a most common and shared software, which is used almost by every teacher for carrying out different type of activities. There are many ways the MS–word is utilized some are as follows:

- Text boxes creation and linking to the drawn or scanned images, where a brief description can be written by students.
- Pictorial representation of the data which is easy for students to interpret.
- Spell check availability which can automatically correct the errors listed in the document.
- Insertion of graphs and tables in the text to make the data easily understandable.
- Word count facility enables to write the text with prescribed word limit.
- Insertion of hyperlinks for ready reference of the data.
- Insertion of still and animated images and videos for making the data more interactive.
- Appropriate sequencing and organization of the paragraphs.
Basically very much interactive worksheets are generated by the teachers to perform
the varied activities in the classroom.

(c) **Microsoft Excel**

Excel as a spreadsheet can be used of scientific data computation for generating
graphs as well as for varied type of data storage for better understanding.

(d) **Microsoft Front Page**

When the worksheet or data available is to made more interactive and user
friendly then front page software package is the only solution that allows linking of text,
video, image, animations, audio clips, internet sites etc. More over front page can be
used for manipulating the images text etc. according to the both teacher and learner use.

(e) **Test construction software**

Varied type of test construction soft wares as well as online test construction
websites is available for example (http://web.uvic.ca/hrd/halfbaked/) Hot Potato. These
web sites and soft wares are equipped with varied features like feedback to multiple-
choice question responses, to evaluate grade range of student’s responses and various
types of tests can be constructed.

(f) **Mind Mapping**

Different type of cost effective and highly effective mind mapping soft wares is
available online and commercially. These soft wares comprises web diagrams that
contains are ideas and information linked together to make a mind map. Major headings
further classified and linked with subtopics, which are further linked with detailed
information. Such type of mind maps allows the learners to link the related ideas and
construct knowledge. Moreover these maps also emphasize on lateral thinking skills.

6. **Other Soft wares**

Some software like, Dream Weaver, Flash, Tool book Instructor etc. are available
which allows the teachers and learners to construct varied type of interactive
worksheets.

A. **Presentation software**

(a) **Microsoft PowerPoint**

It is one of the major tools in the hands of teachers used these days to make the
lesson interesting and effective. To make the concept clearer, interesting and
understandable varied types of images with the text, animations, videos, images, audio clips etc. are added with hyperlinks to attract the student’s attention. Slides once made can be used number of times, shared and updated according to the requirement. Individualized or group assignment can be given to the students regarding science topics and asked them to give presentation on the same to generate their communication skills also.

Power point presentations can be shared with the teachers for improvement and with students after lecture delivery, as from these absentees will be benefitted for revision.

(b) **Image manipulation software**

When ever worksheets of power point presentations are created by the teachers it demands that the scanned or drawn images which are to be added should be manipulated and this is made possible via image manipulation software. Manipulation involves the cropping, resizing or elaborate the images. For example Photo Impact, Photo suite, Photo Plus, Photo Express, Photoshop etc.

(c) **Presentation by students**

It is one of very important strategy to allot individualized or group assignment to the students pertaining to present their task in the form of power point presentation, as it encourages the students to use the ICT packages. This should incorporate:

- Images clicked during practical or microscope work.
- Writing of quality notes
- Production of worksheets
- Production of posters

(d) **Spreadsheets**

Spreadsheets comprise varied features for data computation. For the computation of scientific data spreadsheets is wonderful tool. The analyzed data can be used for versatile scientific activities. Both students and teachers should spend enough time to hone the skills of spreadsheet usage and to get acquainted with the highly refined skills of data computation.

(e) **Drawing graphs from spreadsheet data**

The data available on the spreadsheets can be used as it is but inclusion of charts, diagrams, images, animations etc. can make the data highly interactive and
easily understandable. Specialized skills are required for the same to use full options available in excel sheets to draw appropriate graphs to interpret the data more precisely, accurately and easily understandable. Special assistance of experts is required to the students to train the operational skills of data presentation in a logical and effective way.

**B. Using Science Software**

**(a) CD-ROM on the scientific contents**

To upkeep the scientific data and innovations varied type of CD-ROMS are produced commercially.

**(b) Information and retrieval software**

Compact Discs (CDs) store large amount of information that are equivalent to million text pages. To make interactive, attractive and interesting learning material with text a large variety of images, animations, sound etc. are combined, except that many hyperlinks are attached for navigation of different other relevant resources. Hotspots are also made active at one click to retrieve the information. Varied type of CDs on scientific learning concepts, evaluations etc. are available for both teachers and learners.

**(c) Simulation software**

The experiments of long duration, not easily accessible information and hazardous activities can be designed in a simulation mode. Mainly experiments or industrial processes can be shown via simulation mode and accordingly varied CDs are available regarding the scientific phenomenon and shown to the students to understand the practical concepts and to develop the scientific skills.

**(i) Scientific concepts and industrial processes**

Large no of CDs on scientific concepts and industrial processes are available and these comprises some biological phenomenon like populations and food chains, industrial plants, radioactive decay, interactions with ecosystems etc. Some of the simulated CDs are made interactive for more clearance and understanding of the concepts.

**(ii) Virtual experiments**

Simulated type of experiments can be of virtual type also. Different type of available softwares can be used for operating the experiments in a virtual mode.
The tabulation of data and graph formation is done automatically by soft wares. Both teachers and learners can use this type of experimentation. Teachers can use to give feedback to the students, preparing the students for pre lab work or for post lab analysis of results. The limitation with the use of using CDs is that it mars the productivity of the students and can also result in ineffective tool in some situations. For this teacher has to decide in which form of instructional strategy this tool is to be used for effective learning.

7. Use of Internet

(a) Information searching

There are varied type of search engines available few of them are very common such as Yahoo, Google, Altavista, etc. which provides advanced search facilities and theses engines facilitate in providing up to ate knowledge also as plethora of data base is attached to these search engine. We get highly detailed, relevant information on any scientific and other concepts. Some time wide variety of updated information are not authenticated, distracting from the main task and irrelevant but lot of time is spent aimlessly for fruitless searching.

Teachers has to ensure the effective usage of this in the classroom that students must spend their quality time in net surfing for this teacher have to do prior exercise and those links are to be provided to the students which are relevant and appropriate to the topic so that students can explore the appropriate information timely and quickly.

(b) Chemical structure and Molecular modeling drawing packages

Chemical structure designing and modeling is made possible with the help of ICTs. AS chemical structure and Molecular modeling drawing programmes available both in online and off line mode in the forms of software play vital role for imparting valuable science education. These packages were designed earlier to support chemical and biological research. After rigorous modifications and innovation some sophisticated and highly advanced molecular modeling and structure drawing packages were developed for concept clarity and understanding. To explore molecular models one good exampled site is www.webmolecules.com.
(c) Applets
Applets are the small animated images available on the web pages. Applets help in the conduction lab work in an effective way. These images include: Experiments in the simulated form and animated three dimensional images.

(i) Experiments in the simulated form
- Via applet simulation students can collect the data where quickly when experiments are conducted in a simulated form. Those experiments which are time consuming, expensive and varied type of resources are required for their conduction, for effective conduction simulation is the best solution. The important benefit of applet simulation is that students can get enough time for thinking and they reach at conclusion immediately.
- Animated three dimensional images make the complex phenomenon easily understandable. The complex phenomenon or processes like working of machines and electric motors, Concept of gene mutation long time consuming experiments can be illustrated or explained very easily.

(ii) Internet video
Common types of video clips available include mpg.mov and ram files. Varied type of videos available online on science education can be viewed, downloaded and saved. These video should be used to make the clarity of scientific concepts and to engage the learners in varied scientific activities. For example some search engines, such as Alta Vista and Google, etc. have specific video clips.

8. Three Dimensional Visualizations
To view the science images and models in three dimensional modes varied types of sophisticated, digitized technologies are available. The specific ready made Java files make the possibilities to view the images or model in 3D mode. 3D Java applets and Virtual Reality Modelling Language (VRML) tools are increasing day by day to view the images in 3- D mode. For example VRML files can be viewed with Cosmo Player.

9. Freeware
There are varied excellent examples of freeware soft wares available online that supports and enrich science teaching, for example, different versions of the periodic table. Example of some shareware like www.zdnet.com/downloads/ and other than that
the search engines assists for that by simply using keywords such as science + freeware will explore varied free wares to be used for science education.

10. Publishing Work on the Web

Now days every institution has their own website number of science teachers and students publish and showcase their own work on the website. Like lecture notes, reading material and varied presentations made by students and teachers are published on the website. Some do’s and don’ts must be followed while publishing a work on the website.

11. Electronic Communication

Electronic infrastructure in every institution is on increase now days, varied opportunities are available for the administrators, teachers and students to communicate with mass or individual within as well as outside the institution. Varied ways and means to communicate are as follow:

i. Communication via e-mail:

E-mail is one of the best tools for exchange and sharing of information pertaining to presentation, assessment experiment data and to give feedback as well as for imparting information both for students and teachers in and outside the school. It is also useful tool to link different schools with in and outside country to share common science curriculum.

ii. Communication via video conference: Video conferencing is also one of the very good modes to share the data between teachers and students sitting at different places. For example during seminars or conferences teaching the discussion on science education can be held.

12. Using Interfaces

i. Data logging: Different type of data loggers ,associated sensors and software dedicated to science education are existing now days as it is considered that science students must be given experience regarding this as it allows students to concentrate on experimental technique and control of variables, and to concern themselves with what is happening in the experiment rather than on data collection. For innovations and creativity in experimentation different type of data loggers with new sensors are available.
ii. **Data Logging Sensors**: very much improved and sophisticated sensors are available to get connected with data loggers. With the help of sensors the difficult and hidden phenomenon are made observable like monitoring of heart rate, lung expansion etc. for this specially designed sensors, colorimeter sensor are used for measuring the concentration. Physics experiments associated with rapid change is done with the help of data logging software.

iii. **Data logging software**: data loggers connected with specific and sophisticated software are used to gather, store, retrieve and display the data. Plotting of graphs and interaction with data in a different ways is made possible with data logging soft wares.

13. **Cameras**

For science activities varied camera devices are available and their usages in classroom make the science education and teaching more interesting and effective. Some of the cameras are flexible neck, digital, camcorders, webcams, digital microscopes etc. Further, camera clicked images can be scanned and even the images can be taken via scanner also.

i. **Flexible neck video cameras**: As the name indicating flexible neck video camera comprises a small flexible stalk on which camera is installed. The images captured via flexible neck video camera are further projected on TV screens or computer monitor or data projector.

ii. **Digital Cameras**: very sophisticated digitized camera with different strength and high quality are available the image captured via digital cameras is of very much near to reality. It is very much easy and viable for the students to take the electronic images quickly and further their manipulation for high lighting with the help of image manipulation software. Very refined digital cameras at a very cheap price are available now days.

iii. **Webcams**: The images captured via web cameras (webcams) can be directly attached to the computers for storing and display of images. Different type of moving as well as still images pertaining to scientific phenomenon or processes can be captured for further use.
14. Digital Microscopes

One of the very common digital microscopes namely Intel-Play computer microscope is very good equipment specially designed to capture the electronic microscope images further these images are stored and displayed on the computer. With the assistance of data projectors images captured from digital microscope can be directly inserted into electronic worksheet for get the detailed information as the images captured are of high quality.

15. Scanners

Almost every school has facility of scanning done with the assistance of have scanners. For science teachers it is one of the very important and essential tools. Both teachers and students can use scanned images for making presentations, posters and reports. Scanned images can be projected and zoomed for better understanding. The precaution to be followed for taking scanned images is to give due consideration to the copy right issue.

16. Mobile ICT

Mobile ICTs are very much useful in science education as these have huge potential to make the learning easy for science students. Another name of mobile ICT is 'm-Learning'. It is a new way to learn using small, portable computers such as personal digital assistants (PDAs), handheld computers, two-way messaging pagers, internet-enabled cell phones, as well as hybrid devices in which one, two or more devices are combined to make the effective and efficient usage (Hunsinger 2005).

1.8 PROCEDURE FOR INTEGRATION OF ICT TOOLS AND RESOURCES:

For integration of ICT tools and resources in class room process the procedure to be followed is as prescribed below:

Step 1: Determining ICT based tools and services: This stage mainly concerned with discovery of new ICT based tools and services which are to be adopted by teachers and students to achieve the desirable objectives and learning outcomes. This is linked with the emerging approach in ICT development.
**Step 2: Learning how to use ICT tools:** This stage mainly focus on learning the use of discovered ICT tools. It involves the learning, how and when to use the selected or discovered tools for achieving the desirable outcomes.

**Stage 3: Understanding how and when to use ICT tools:** It emphasizes on understanding how and when to use ICT tools to achieve pre defined objectives. It depends upon the teacher’s capability and potential to recognize and understand, how much appropriately a single tool or in combination of several other tools are utilized with precision, for particular activity to resolve the problems.

**Step 4: Specializing in the use of ICT tools:** This step demands in depth knowledge and acquisition of specific skills about using ICT tools. It is used for teaching by the teacher and by students for learning to become specialists in the use of ICT.

For the usage of ICT facilities in the science teaching the teacher plays a crucial vital and merging role as she is the main element to make the maximum use of ICT and further can motivate the students to use the same.

Ideal learning environments are generated by the ICTs as these are responsible for generating effective learning environments and support for learning (Glickman 1991). What type of learning outcomes are to be achieved, what type of learning strategies are to be adopted, what type of learning resources are to be used etc. are the common questions which bothers the teachers when she plans the teaching. The major aim to be focused in the classroom is to generate that type of learning environments which is student centered in which plethora of opportunities are to provided to students that hey should learn and understand what the teacher want to teach. The learning environment to be produced in the class is of utmost importance it can be made effective with the usage of ICTs and also without ICTs. So it becomes very essential before lending ICT support to recognize the objectives to be achieved by students, teachers, school etc. While teaching, the important point to be kept in mind is that what type of learning environment whether ICT based or without ICT based it should be of constructing new and durable knowledge.

Teacher has to decide what type of support is to be rendered to students, whether they should rely on traditional method or new ICT based strategies to achieve the desirable learning outcomes.
1.8.1. Key Points about Successful Pedagogical Strategies Utilizing ICTs for Teaching and Learning: there are following key points for successful pedagogical strategies utilizing ICTs for teaching and learning

(i) Pivotal role of teachers: no doubt teachers always has to play central or leading role in generating appropriate teaching learning environment whether it is ICT based or without ICT based, they must be imbibed with leadership skills to be as a leader in the classroom for pre, interactive and post activity of teaching. The leadership skills are essential while using ICTs.

(ii) ICTs based Planning of lessons is crucial:  
The lesson planning becomes very much weighty when using ICTs what type of ICT based tool or equipment is to be used for a particular content at what time and for how much time all is to be done during planning. If very little or defective planning is done, research showed students will not be focused in the classroom and further, it will result into lower achievement.

(iii) Simply ICT introduction will not change the classroom processes:  
Simply the ICT introduction will not change the teaching learning processes. For these teachers has to develop refined skills of ICT usage in an effective way. They have to plan the pedagogical strategies accordingly. For this teaching practice is to be done in ICT enabled condition and environment. As the nature of ICTs used has impact on students’ achievement.

(iv) ICTs as an important tool to create ‘learner-centric’ environments: It is evocated by the researchers that the most effective learning environment can be created via ICT and that environment becomes more effective and efficient when it is learner centric. These environments essentially demands ICT supported learning environment, whole class discussion individualized or group activities instilled with ICT.

(v) ICTs essential tools to support and extend teaching practices: the existing teaching strategies, practices, teacher taught interaction and way the teacher provide feedback to the students is changed this change is fetched with the support of ICT. The teaching learning environments are refreshed with the assistance ICTs.
(vi) ICTs as an effective tool for information presentation:

Varied type of available tools like overhead and LCD projectors, television, electronic whiteboards, guided “web-tours” etc. can be used for imparting information. Via these tools images can be manipulated by giving animated and simulated effects for better explanation as well as better understanding of the concepts. These tools bring real world in the classroom.

1.9 ICT BASED TOOLS AND RESOURCES INTEGRATION IN SCIENCE TEACHING

Integration of ICT is becoming essential in science teaching. It is obvious that ICT based tools such as projectors, interactive whiteboards, digital microscopes, videos, animated images, internet, handouts, model data, CD-ROMs, etc. when used for educational processes will definitely contribute in the professional development of teachers and academic achievement of students. Since the conception of science education as a field in the 1950s, many explanations and investigations are performed about imparting effective science instruction for producing problem solvers and innovators. The aim of teaching science is not, rote memorization for understanding but it demands that students should stay as active and engaged learners.

Vardhini (1983) conducted study to develop multimedia based instructional strategies for science (Physics and Chemistry) teaching at secondary stage. Following conclusions were drawn from the study:

I. Almost all the units indicated average/high level of performance on the total test.

II. The strategy was found valid against the criterion of scientific attitude in that significantly higher performance was noted for the group in the posttest over the pretest.

III. Validity of the strategy was established from reactions expressed by students for its continuance and also their improvement in science achievement.

IV. Intelligence and achievement using the strategy presented a significant relationship.
V. A significant relationship was found between scientific attitude and achievement for the experimental group and control group.

VI. Visual projections with teacher explanation and those with taped commentary were equally effective in terms of achievement.

VII. Programmed material and discussion sequence were equally effective on the total test.

VIII. The strategy was found feasible when seen in terms of its reproducibility and the cost management by individual schools.

Trowbridge and Wandersee (1989) established that students should be encouraged and inspired to read and write by using information and communication technology, by employing the internet, students have access to meaningful information and consultation, for example, electronic books, hypertexts and hypermedia in the CD-ROM format or diverse web-based hypermedia documents, such as www-pages, learning activities will help students to create a network of concepts and it seems to be advantageous for science learning.

Hamza and Alhalabi (1990) recognized that to take the students beyond traditional methods of teaching like creation of virtual environments for experimentation and exploration only technology can help and support for this.

Baker, Misner and Cooney (1991) explored that spread sheets contribute a lot for data presentation, modelling and simulations in science education at different levels, complex physics problems can be resolved simply usage of spread sheets.

Role of the teacher is totally transformed now he is no longer as all the information bearer or controller of all the classroom activities. He now, acts as a learner and explorer with close collaboration of pupils. In particular, teacher now generates open-ended learning environment for the students (Hannafin and Savenye, 1993; Keeler, 1996). Webb (1993) recognized some commonly used ICT tools namely graphics packages, scanner, digital camera, video, presentation applications, databases, spreadsheets for teaching of sciences.

Both skill-based and open-ended soft wares are preferred by the teachers the basic difference between the two is that teachers who follow traditional approach of
instruction use skill-based software, whereas teachers who adopt constructivist approach they use both skill-based and open-ended software.

Gardner et al. (1994) and Beare (1991) concluded that scientific theories, principles and processes are very easy to follow these days this is made possible by educational technologies as these technologies have potential to perform multiple tasks and services like visualization, modeling, and multiple representations. Further it was also concluded that appropriateness of usage of technology is also very much considerable.

Bliss (1994) explored that the usage of models promote learning as they are very much interactive. Further it was explored that models should have interactive features that help and facilitate in developing the understanding of processes.

Studies conducted by Baxter (1995) Lewis, Stern and Linn (1993) clearly acknowledged that technologies have immense capabilities and potential for modifying the explanation of complex or abstract concepts into easy and simple way, such as computer visualization techniques for teaching of science. Tinker (1996) observed that Microcomputer-Based Laboratory (MBL) tool in a combination of the hardware and software used for collecting data (data acquisition) using sensors/ probes (such as temperature or pH sensors) connected to a microcomputer through an interface helps in the analysis and display in graphic form, in a real or delayed time.

Millar (1996) argued that in the Computer-assisted inquiry, ICT is an aid for collecting information and data from various sources. For example Microcomputer-Based Lab (MBL) tools and Web Based Learning Environment (WBLE) is used as a source of information.

Jarvis et al., (1997) noticed that, no evidence is found that usage of e-mail promote learning in science. No doubt great enthusiasm was seen both in students and teachers. Further it is perceived that it has contributed in the distraction from learning science. Moreover it has helped in developing the ICT skills.

Dodge (1997) helped to promote and develop an idea of integrating internet resources in student-centered activities, which develop the potential and capacity in the learner to encourage and acquire relevant, interactive, and authentic learning.
Aldrich, Rogers and Scaife (1998) acknowledged that science students when use ICT, not only they make choices about the pace and order of a presentation, but can choose topics, take notes, answer questions, explore virtual landscapes, enter, draw or chart data, run simulated experiments, create and manipulate images, make their own multimedia presentations, communicate with others, and much more. McFarlane and Friedler (1998) illustrated clear evidence of enhanced learning through the use of data logging. Further it was also found that by including ‘hyperlinks’ in the worksheets pre selected information on the internet can be accessed, for example ‘Encarta’ an important encyclopedic database.

Baggott and Nichol (1998) furnished that multimedia tool like ‘Interactive Microscope Laboratory’ due to its interactive features helps to observe and investigate experiments via simulation as well as virtual mode for example measurement of heart rate via simulating the functionality of advanced microscopy, Remote animal habitat via virtual reality field trips etc. The simulation and virtual reality phenomenon can be repeated when ever necessary for the learner which is impossible during live practical.

The use of ICT may foster co-operative learning and reflection about the content (Susman, 1998). In Technology-enhanced Secondary Science Instruction (TESSI) project (Pedretti et al., 1998; Mayer-Smith et al., 2000) varied type of technology was employed like (a) simulations (b) laser video and compact discs (c) graphical analysis tools linked with sensors and probes (d) digitized video (e) presentation software and (f) interactive student assessment software, all were envisioned to impart instructions. It was further, inferred that with the usage of technologies students were purposefully involved and have more engagement in classroom processes.

The nature and type of ICT used contribute a lot in building powerful learning environment. Sinko and Lehtinen (1999) pointed out that there is no standardization which learning environment is best, the gaps always exists between the intended learning environment and implementation. Different type of soft wares are used which help the students to build knowledge e.g. open-ended soft wares (Squires, 1999).

Both the selection and usage of software has significant effect on the learning environment. For this, the skills of teacher for selection and usage play an important role (Smeets et al., 1999 and Veen, 1995).
ICT has open varied new ways to access or view the information with the help of multiple resources from varied perspectives, with this the learning environments generated found to be more authentic.

Singh (1999) conducted developmental cum experimental study on environment education and it was evidenced that the teacher made video-instructional packages was very much effective in terms of students’ achievement.

Noss and Pachler (1999) inferred that with email and video-conferencing, there is no longer a need for teachers and students to coincide in time and location. Electronic communication provides varied opportunities to collaborate with peers and experts from outside the classroom and the school. Bhattacharya and Madhumita (1999) investigated the critical review of work done on the use of computer as an instructional tool for teaching chemistry. The main objectives of the study were to aim at developing tools, for evaluating the effectiveness of available software in chemistry and development of software in different areas of chemistry and it was found that available software in chemistry was of good quality.

Kewalramani (2000) conducted a study on effectiveness of TV based instructions and feedback on use of television. It was concluded that students performed much better in the science subject who were instructed through TV based instructions as compared with students who were taught traditionally. Further, positive feedback was recorded for the television based instructions.

Research results of Newton (2000) established that for the performance of lab work with precision and accuracy ICT plays a major role, like for recording observations, storage of data and computation of data with the help of data loggers and also for the presentation of data in a very simple and interactive way.

The worksheets that are generated from gathered information are made interactive by incorporating varied type of diagrams, animation, hyperlinks etc. which saves time for better understanding of the scientific concepts (Hitch, 2000).

Jackson and Songer (2000) found that videos, music clips and audio recordings available at the internet have the immense potential and great affordance in project-based science learning. McFarlane (2000) argued that use of graphing applications of
spreadsheets in science classroom can allow data handling exercises to focus on presentation and interpretation, rather than simple construction.

Gilbert and Boulter (2000) established that the purpose of any model in science is to simplify a phenomenon and to make an explanation of a particular concept. Consequently, models have several features in science education, these help pupil to learn about science, the history of science and methodology and, moreover, to learn to do science.

Jonassen (2000), Andalora and Bellomote (1998) found that in science teaching varied tools used for data capturing, processing and interpretation like database, spreadsheets calculators, graphing tools, modelling environments etc. are found to be very much effective.

Language of science is fundamental for conveying meaning, not just through verbal language but also through a combination and interaction of words, pictures, diagrams, images, animations, graphs, equations, tables and charts and these are unsurpassed tools for the scientific language expression (Osborne, 2001 and Jones, 2000).

Kennewell et al. (2000) unveiled that placement of computer in the classrooms facilitate and provide the massive opportunities to the teachers to have maximum utilization of the computers for varied classroom activities. It will help to cessation of teachers’ notion that computers can not contribute to learning. As powerful learning environment will be generated with the help of ICT as it play important role in classroom processes (Drenoyanni and Selwood, 1998; Hokanson and Hooper, 2000; Higgins and Moseley, 2001).

Furthermore, ICT may serve as a tool to curriculum differentiation, providing opportunities for adapting the learning content and tasks to the needs and capabilities of each individual pupil and for providing tailored feedback (Smeets and Mooij, 2001). It was pointed out that ICT can fit into a spectrum of instructional approaches.

Tubi and Nachmias (2001) inferred that electronic mail, newsgroups, chat rooms, blogs, Wiki, and videoconferencing are used for educational purposes in the distance learning approaches. For example a newsgroup can be used for facilitating students’ homework. A large number of websites that focus on science topics were developed.
for academic purposes by the instructors. Lecture notes, homework projects, online books and complete courses in science, physics, chemistry or biology are also available on the Web.

Loads of accountability lies on science teacher how judiciously, aptly and effectively ICT is used in the classroom processes. Thomas (2001) corroborated that teachers must have understanding and knowledge that with the usage of which particular ICT based tools specific learning outcomes can be achieved for example, the sanitized data produced by simulations may lead to misconceptions.

Muchal (2001) conducted a study on effectiveness of pedagogical strategies and concluded that printed lessons were not effective when compared with video lessons. As well as post video discussion was found to be more effective than printed lesson.

Rogers and Newton (2001) explored potential of ICT for supporting investigative work in practical science. Their work suggested that the software had been successful in promoting students’ abilities to collect and manipulate data, but less successful at making links between the data they had collected and the associated science. Christian and Belloni, Schraw, Flowerday and Lehman (2001) observed that one widely used simulations in science education are Java applets/physlets which can be found in the web-pages.

It has been reported in a pilot study of digital video in 50 schools across U.K. when a topic namely ‘forces’ after editing converted into a piece of film that helped the students to learn the scientific concepts in a more effective and rapid manner than with the help of handouts or textbooks. (Reid, 2002)

It was seen that in e-learning, e-teachers have choices to prepare their own audio and video presentations to make isolated e-learners feel their presence and to enhance their learning with the use of e-mails, e-forums, video conferencing, chat rooms, messaging, bulletin boards and other types of online communication. As a learning tool, we can employ open generic software in science teaching (Lau, 2002).

These days, the tools which can be used in practical activities are considered as the most important form of ICT usage for science teaching and learning (Barton 2002). Gilmore, Kachelhoffer, Morrow, Moeau and Wenmouth (2002) had explored in their study that the science teachers can make use of ICT for the preparation of their

64
lessons, to search innovative ideas from the internet, to prepare worksheets and tests in word processing packages such as 3-D achieve.

Balasubramanian and Meera (2002) conducted a study on relative effectiveness of different modes of computer-based instruction in teaching Biology. The major findings of the study were:

I. CAI in drill and practice is more effective than the tutorial and simulation modes in teaching biology at standard XI (II) more software packages can be developed for the whole syllabus which will help the students to learn at their own pace (III) the CAI packages in Biology should be planned, developed, evaluated and implemented with the help of a team of experts constituting curriculum planners, educational technologists, computer experts and biology teachers. It will be helpful in the development of quality packages in the teaching and learning of Biology.

Sharma and Sansanwal (2002) conducted a study on comparison among video-based instructional strategies for teaching science at class IX level in terms of achievement. The study aimed to compare the mean scores of achievement of student in science belonging to different video-based instructional strategies for teaching science at class IX level. The findings of the study were: (I) The treatment had significant effect on achievement in science of students belonging to different video based instructional strategies for teaching science (II) the video viewing followed by lecture as well as video viewing followed by discussion were significantly higher than those of video viewing only (III) the mean scores of science achievement of video viewing followed by lecture was found to be significantly superior to video viewing followed by discussion.

Some studies on the use of ICT in science simulations have focused on the most difficult aspect of science teaching, developing students’ conceptual understanding of difficult science topics. Students in ICT-supported science classrooms also got benefit from the instant feedback from experiments, as well as the chance for more independent and self-directed learning (Baggott La Velle et al., 2003).

Different type of ICT based visualization tools can make the abstract real, and help the students to understand the chemical concepts thoroughly. Dori, Barak and Adir (2003) accomplished that the advantages of use of ICT tools for visualization. Images of
the micro and macro world, static graphics of chemical structures, found in textbooks, may help the learners to form two dimensional mental images, but ICT based tools allow for 3D visualisation of molecules. These also allow students to view, rotate, measure molecules, as well as modify or construct new molecules.

Importance of ICT was recognized decade back and it was integrated into the schools. Now it has become mandatory to use ICT for science subject to have effective teaching (Balcon, 2003). Data logging is a highly versatile ICT tools for use, in experimental science at any level. Higginbotham (2003) described children ‘playing’ with a temperature sensor and discovering that they could find out whether it was in hot or cold water by watching the screen and they interpreted the graphical data effectively.

Osborne and Hennessy (2003) argued that simulations, as a tool for practical work completely remove any mechanical manipulation of equipment, thus eliminating experimental error. With the help of data loggers data outside the labs can be collected for longer duration moreover these devices increases flexibility and efficiency.

The 21st century skills with new educational goals supported by an increased use of technology are difficult to assess in traditional ways and it is argued that there should be assessment criteria different from traditional assessment criteria when computer-based testing is used (Mcfarlane, Ridgway and McCusker, 2003). Ball (2003) argued that many teachers are not confident enough to use data loggers effectively in their science lessons.

Desai (2004) did a comparative study of the efficacy of teaching through the traditional method and the multimedia approach and concluded that the mean achievement of the experimental group was found significantly higher than that of the control group. Towards multimedia approach students have positive attitude. Osborne and Hennessy (2004) exposed that it is not appropriate to assume simply that the introduction of learning technologies in schools necessarily transforms science education. Rather, we need to acknowledge the critical role played by the teacher, in creating conditions for ICT-supported learning.

Computers can be helpful in reading and writing texts, in playing games, for tutorials and drill and practice mode and simulated experiments. Collier (2004) concluded that the CAI are quite effective than the traditional one.
There is no qualm that interactive videos, e-books, e-journals, power point presentations, animated videos, etc. are available on the internet. But handouts and model data also have tremendous impact on the education and will continue to provide advantages both to the teachers and students (Department for Education and Skills, 2004).

In terms of educational value of web Kuiper et. al. (2005) have identified and summarized, four characteristics of the WWW which include (i) a huge scope containing up-to-date written sources of information which offer both general and specialized information, (ii) easy access by students who are both information consumers and providers of information, (iii) a hypertext structure which allows text, opinions and ideas to be linked to one another and, (iv) a visual character.

Denby and Campbell (2005) revealed in their study that there are ample of websites which provide number of science related information like web site of Association for Science Education (ASE), The Institute of Biology (IOB) web site, The Institute of Physics (IOP) web site, and The Royal Society of Chemistry (RSC) web site which can be helpful for the science teachers to plan their lessons.

Dawson et al., (2006) explored in the report that in Australia, science teachers are fully equipped with the ICT resources and they use the same for the preparation of curriculum, teaching learning process and for data analysis and reporting of results.

Ramboll (2006) documented that, teachers reported a positive impact of ICT on pupils in terms of performance and also consider ICT as a tool to support both content and pedagogy, ICT can be used in the project oriented, collaborative and experimental methods.

Becta (2006) unveiled, how the teachers can make use of ICT effectively in their subjects. Association for Science Education (ASE) evaluated over 10000 lessons. It was observed that the use of ICT in an effective and well managed form motivate to the younger students for more experimentation, for analysis and presentation of results. ICT has also benefitted the science teachers by providing them science material on the internet. The science websites provide students and teachers different forms of lessons which can be used in the classrooms for simulation and also for presentation. It was also
reported that still there is a need to promote ICT tools in the schools like computers, data loggers, colored printers, electronic whiteboards and digital microscopes.

ICT-based science approach provides students a swift access and learning environment for new information. Dawson, Faster, and Reid (2006) earmarked that reasonable application of ICT can make our teaching effective, flexible, and multiple. To meet our multipurpose approach, it can manifest demonstrations, uplift students’ thinking levels, facilitate problem-solving, and offer learning tools to construct knowledge and promote scientific abilities.

Lavonen, Juuti, Aksela and Meisalo (2006) furnished that the ICT used in science education can be classified as (a) tool applications (use of tool software) and (b) ICT use in learning (learning through ICT). The main uses of ICT in learning (b) can be divided into two different categories for directly supported learning: (b1) Computer-assisted learning (CAL) it is an interaction between a student and a computer system designed to help the student learning. For example, a student can learn with interactive educational software or training software or computer tutorials. (b2) Computer-assisted inquiry (CAI) it is the use of ICT as an aid in collecting information and data from various sources to support scientific reasoning.

Nood (2007) generated a powerful e-learning environment by creating a website for both teachers and students of science which included lecture, video demonstration and interactive assessment. This website was proven as a thriving e-learning environment for the teachers in their teaching with the help of simulation that was installed in this website.

Jyoti (2007) revealed on computer based learning that the instructional module prepared by the chemistry teacher through simple presentation had great impact on learning of chemistry students. Although the presentation was simple but even then it was proved very beneficial for the physical science teachers in imparting instructions.

Prodigious importance is to be given for number of leaners available and number of ICT tools available for them. Zucker and Hug (2008) in his study concluded that when one-to-one laptop to student ratio was provided to secondary-level physics students in American charter schools. The mixed-mode qualitative and quantitative evaluation of these laptop-specific ICT strategies was adopted and laptops were also
used in a variety of networked and stand-alone ways. The project resulted into solid success as students were found more engaged and motivated for learning.

In the research report Digital Horizons: Laptops for teachers’ evaluations, Cowie et al. (2008) concluded that positive attitude of teachers was observed about the advantages of multimedia resources like educational websites and for the hard copies of course materials provided to them. It was also established that many of the science teachers were using laptops in preparing reports of students for parents and keeping the records of students’ data.

Webb (2008) and Mc Farlane and Sakellariou (2002) explored that the use of digital simulations as a specific application of ICT has received much attention in science education, the obvious benefits to school science was that, these enabled the students to explore and investigate phenomena which were not possible in the classroom.

From the exceeding it is apparent that varied types of ICT tools are used for teaching and learning of science. ICTs can be considered as significant for the identification, collection and maintaining records of the students’ learning and in maintaining a community of learners. Wide range of ICT tools are available but there are five main tools used for creating learning environments like problem or task representation tools, knowledge modeling tools, performance supporting tools, information gathering tools, conversation and collaboration tools.

Academicians contemplates that the students can construct their own knowledge, if the educator provides them an environment in which they are supported with the learning activities and can perform their role as a learner. That environment should be learner-centered and learner-focused. The learner is that who construct his own knowledge with the help of his thinking process like analysis, synthesis and evaluation. For all this the need arises for ICT enabled learning environment supported with ICT tools and services is to be provided.

1.10 EFFECTIVENESS OF ICT MEDIATED SCIENCE INSTRUCTIONS IN TERMS OF ACHIEVEMENT

The present era is of a competition. In this rapidly changing society, students are conscious about their achievement. At every step in life, academic records speak for an individual. Achievement is synonymous with the accomplishment or proficiency of
performance in given skill or body of knowledge. Achievement refers to the level of success or proficiency attained in some specific area concerning scholastic or academic work. “The death of endeavor and the birth of disgust is achievement.”

According to Aristotle, “For what is the best choice, for each individual is the highest it is possible for him to achieve” Achievement is ability to demonstrate accomplishment of some outcome for which learning experiences were designed. Achievement is something accomplished successfully, acquirement, acquisition, attainment, effort and feat especially by means of exertion, skill, practice, or perseverance.

Conditions for the achievement are motivation, external stimuli, synchronization, time, self-confidence and confidence in the setting, interaction with others, collection, analysis and organization of information, enterprise, behavioral attitudes, problem-solving capabilities and psychological attitude. In common terms, achievement is the realization of a goal and the attainment of an objective. Achievement is both intentional and satisfying, and it does not happen by accident.

According to most of the policy makers and parents, achievement simply means raising test scores in basic skills. The mastery in only basic skills like reading, writing, and arithmetic is insufficient for preparing the child for modern world. In fact, this emphasis may exacerbate students’ alienation from schooling. Very much comprehensive, relevant and more contemporary definition of achievement is acquiring and mastering in basic skills, maximum utilization of ICT resources and services, persistence efforts for 21st-century literacy, ambition by the students to execute lots of innovations and develop as an innovators and technocrats for productive future. On the basis of achievement the individuals can be broadly designated into three categories:
(a) High achievers: the high achievers are defined as those who achieve higher than what is expected to their intellectual level.
(b) Average achievers: the average achievers are defined as those who achieve normal or what is expected to their intellectual level.
(c) Low achievers: the low achievers are defined as those who achieve low than what is expected of their intellectual level.
When ICTs are extensively used for the underachiever students for enhancing their sense of achievement and motivation. An exceptional learning and motivation improvements were observed in literacy and mathematics (Moseley and Higgins, 1999) geography and English (Hennessy, 2000; Van Daal and Reitsma, 2000) and for special needs students in terms of producing higher standards of work (Harris and Kington, 2002).

There is a well-maintained relationship between the students’ achievement and the use of ICT. It shows that the most important constituent in selecting and using the technology is the teacher and his or her ways of teaching. Proper use of ICT has its positive impact on students’ achievement which will be helpful in achieving the objectives. ICT resources that are integrated in teaching by the teachers have its positive effect on students’ achievement. The effects of communication tools such as email and WWW can be seen on students’ achievement but still the evidence is not yet reliable and extensive.

Learning environments that are created by the ICT should be learner centered as they learn more from doing the things by themselves rather than by what merely told to them. If we have to provide the learning opportunities and to improve the learning activities, there is a need to pay consideration towards the effectiveness of learning environment, whether they are with or without ICT.

NCET (1994) explored that in teaching science visual aids and video demonstrations can be used to teach the difficult concepts. Simulations and models can also be used to enhance the learning.

Worthen, Dusen and Sailor (1994) found that students using a computer integrated learning system (CILS) in both laboratory and classroom settings were more actively engaged in learning than students in the non-CILS classrooms. Further it was established that student-teacher interactions were more student-centered and also individualized during computer-based teaching and learning.

In one of the study conducted by Sindhi (1996) designed a multimedia package for teaching physics. It was established that teaching of physics with the help of multimedia packages were proven to be more effective than the traditional method of
imparting instructions. It was further explored that the student also remembered the concepts for a longer time.

Joshi and Mahapatra (1997) evidenced regarding effectiveness of computer software in terms of reasoning ability in science. Objectives of the study were to compare the developed software package with traditional method in terms of reasoning ability in science by considering intelligence as a covariate. They concluded that traits like reasoning ability in science of the students was thoroughly developed when taught with software package and also differed significantly from those who were taught through traditional method, when intelligence was taken as a co-variant. Thatte (1998) revealed in an experimental study that use of A-V aids in teaching of science is more effective method of teaching in comparison to traditional method in terms of students’ achievement. Programmed learning and A-V aids are more beneficial for small class and for the students who are of average category.

It was explored in the research that use of computer modelling and simulation increases the chance for learners to understand and investigate complex models and processes very easily when compared with routine laboratory work (Cox 2000; Linn 1999; Mellar et al. 1994).

Samal (2000) inferred that both the Education Television (ETV) and School broadcast programmes have their good impact on students’ learning experiences. A mixed type of responses from both students and teachers were recorded about contents and presentations of the ETV and School Broadcast programmes.

Patel(2001) conducted a study on learning through computer assisted learning material(CALM) and concluded that there is more interaction among students while studying through CALM. The achievement has been found quite high with learning through CALM than with simple teaching. Tare (2001) explored on the effectiveness of branching type programmed instructional material as diagnostic and remedial tool and concluded that the achievement of the experimental group is high than that of the control group.

Digital resources offer a variety of cognitive affordances for science learners. Using a combination of text and pictures together can enhance comprehension and retention (Mayer, 2001).
Vekaria (2002) conducted a study a video instruction programme and unveiled that the video instructional programme was proved effective in both rural as well as urban areas, further acknowledged that the students and teachers have positive attitude towards this programme.

Studies also suggested that by eliminating experimental error and increasing visual impact, simulations can improve scientific understanding (Huppert et al. and Trindade et al. 2002).

Chalmers (2002) argued that ICT has a potential to support and nurture science education. Further it was also supported by Murphy (2003) that when presentation technologies are integrated by science teacher in the classroom the learners in this environment get reinforcement and it also enhanced the confidence level of students. The major accountability lies on teacher how well ICT resources are utilized, organized and managed in the classroom.

Vasanthi and Hema (2003) revealed in their study that (1) There was a significant difference between the mean gain score of the control group taught through Traditional Teaching Method and the experimental group administered by the CAI (ii) there was no significant difference between the mean scores of the pre-test of control group taught through Traditional Teaching Method (TTM) and experimental group administered by CAI (iii) there was a significant difference between the mean scores of post-test of control group taught through TTM and experimental group administered by CAI.

Macwana (2004) explored on the study conducted on the development of Computer Assisted Learning Material (CALM) and measured achievement and the reactions of students. Significantly Computer Assisted Learning Material has been found to be very effective in terms of students’ achievement. Reaction of the students was also significantly positive towards instructions.

Sharma (2005) attempted that an instructional package was considered useful in better understanding of environment topics. The responses that were given by the students in the interview schedule showed that it had increased awareness in the students regarding environment and better understanding of environment.
Kohli (2005) conducted a study on efficacy of computer assisted, concept attainment models on students’ achievement in environmental science subject. The findings were: (I) Computer Assisted Model and Concept Attainment Model were found to be effective in improving the achievement level of students (II) learning with Computer Assisted Model and Concept Attainment Model changed the aptitude and interest of the students. Unlike conventional method, students got feedback and remedial teaching which automatically improved student’s achievement and promoted their self-concept (III) Computer Assisted Model and Concept Attainment Model was shown to be very effective in enhancing the emotional intelligence of the students.

Rogers (2006) analysed the use of simulations and modelling software in science education and claimed that science teachers have embraced the use of simulation software more enthusiastically than modelling software. Some simulations are visual aids, chosen for their ability to help pupils to visualise complex or abstract phenomena. Others feature of virtual experiments is to allow pupils to perform pseudo-laboratory activities and obtain quasi-experimental data.

Polman and Pea (2007) established that in the classroom, where learning objects are encountered in a social and discursive environment, digital resources can help teachers and students to slow down and focus on the intermediate cognitive processes of observing, predicting and explaining that are central to science inquiry and understanding.

There is evidence that focusing on specific areas of difficulty in science and addressing those with carefully designed ICT-based simulations can lead to productive learning (Webb, 2008). Nimavathi and Gnanadevan (2008) conducted a study on effectiveness of multimedia programme in teaching science. The findings of the study were: (i) There was no significant difference between the experimental group and control group in the achievement of science at pre-test level; (ii) there was a significant difference between the experimental group and control group in the achievement of science at post-test level. The students learning with the help of multimedia program were far better in science than the students learning through the conventional method.

Mustafa and Turgay (2011) conducted a study on the effect of computer assisted instruction with simulation in science and physics activities on the achievement of the
students. At the end of the study it was perceived that out of the two groups whose successes were the same at the beginning came out more successful on whom CAI method was applied than control group on whom traditional method was applied.

Researches indicate that varied type of ICT mediated instructions with varied types of ICT can make a difference to pupils’ learning and achievement. The substantial gains in pupil attainment are achievable where the use of ICT is planned, structured and integrated effectively.

The methods adopted by the science teachers in school to teach the students are influenced by the type of facilities and resources that are provided by the schools. In exchange, the level of involvement of the students and their performance is influenced by the teaching methods. Generally, in the schools where the resources –teachers, textbooks, laboratories, tools and equipment etc. are found in insufficient, the teaching approach is likely to be teacher-centered. This type of approach is fully dominated by the teacher as he or she has the responsibility to teach, providing notes and demonstration of the lesson. In the teacher centered environments the students are expected to be passive and merely listening the lecture. The teacher is the only source of knowledge for the students. This can be dangerous where the teachers are not properly trained in the art of communication. A teacher who is teaching with the teacher-centered approach is not good for science teaching and learning as it will result in disinterest of students in science subject.

When there is availability of all the necessary facilities and resources for the teachers then they teach through learner-centered approach. That teacher will provide the students with enormous opportunities to have practical experiences, experimentation, discussion etc. This approach arouses curiosity, imagination and critical thinking in students. It makes the lesson more exciting and attractive for the young students. Therefore an important role is played by the learning resources.

1.11 PHYSICAL FACILITIES

A school without facilities, either government, private or public, may not be able to achieve the stated goals and objectives of the system. When facilities are accessible and skillfully utilized, they influence learning and making it more evocative. Facilities in education are very vital because they aid teaching and learning.
The dictum that “teaching is inseparable from learning but learning is not separable from teaching” is that teachers do the teaching to make the students learn, but students can learn without the teachers. Learning can occur through one’s interaction with one’s environment. Environment here refers to facilities that are available to facilitate students learning outcome. It includes books, audio-visual, software and hardware of educational technology; so also, size of classroom, sitting position and arrangement, availability of tables, chairs, chalkboards, shelves on which instruments for practical are arranged.

Physical facilities are the resources in the school system both physical and non physical which are specially designed for varied purposes. These facilities are basically used for teaching-learning process like:

a. For the illustration and explanation of contents
b. To give first hand experience to the students
c. For varied type of laboratory work like experimentation and demonstration
d. To investigate and discover some scientific facts
e. To build new knowledge
f. For the purpose of observation and inquiry of facts
g. For development of scientific attitudes and skills
h. To protect the individual and also provide comfort

Science is a hands-on subject in which students experience science by carrying out investigations. Generally these investigations require equipment and materials to be set up before a class starts and taken down when the class ends. Planners should determine the appropriate cost of new or renovated science facilities before budgets are set as their costs differ a lot from standard classrooms.

“We shape our buildings, thereafter they shape us.” - Sir Winston Churchill

For providing and ensuring quality education it becomes very much essential to provide very sophisticated high quality facilities in terms science text books, journals, magazines, qualified competent teachers, teaching aids, well equipped library and laboratory, co-scholastic activities, science club, science fairs and exhibitions, science museum, botanical garden, excursions and visits to places of scientific importance, improvisation of low cost teaching materials and above all Information and
Communication Technologies (ICTs). Science education should be such much effective that it should produce technocrats and innovators.

The utmost prioritization of 21st century is to make the life easier and comfortable by acquisition of more and more knowledge. The restraint for all this lays on the science and accordingly highest importance is to be given on science education. To achieve these objectives the dire need arises to redesign science curriculum as per the emerging trends of the modern world. To cope with the modern age, science should be taught effectively in the schools so that every student acquires fundamental ideas related to science.

ICTs provide students and teachers with new tools that enable improved learning and teaching of science. In India, various ICTs have been employed over the years to promote primary and secondary education. These include radio, satellite based, one-way and interactive television, and the Internet. However, there have been enormous geographic and demographic disparities in their use. Some states in the country currently have an enabling environment in place that allows for a greater use.

Leeper et al. (1968) claimed that the child learns through concrete rather than abstract experiences. Physical facilities help to enhance the learning of the students.

According to Propst (1972) all the resources whether human or non human should be properly planned and managed by the planners and the management. There are varied type of resources which demands to be designed in an efficient way like building systems, acoustical, graphic, lighting and audiovisual design engineering, behavioural sciences, community and press relations, ecological studies, electronic data processing of programme development and hardware specifications, use of physical facilities training, food service planning, health care planning, financial planning information management, installation supervision, interior design, laboratory planning safety planning and much more.

To attain the educational goals physical facilities are very much important. Some facilities are made of specific function and some are made for multiple functions. Simpson and Anderson (1981) exposed equipment as “items that last a minimum number of years or cost more than a certain amount” and supplies include all the items
such as microscope slides, glass tubing, and cotton swabs, consumable items and that are usually less expensive than equipment items.

Balogun (1982) established that for effectiveness of science education programme equipment are very much essential. McGuffey (1982) after doing meta-analysis found that age of the building, heat conditions, lighting, color and interior painting, acoustics, building maintenance, lab facilities, and school size plays a significant role in student’s achievement.

Ogunniyi (1983) divulged that pivotal role is played by laboratories for imparting science instructions as in lecture method only chalk, talk and taking notes is major activities but in practical method students have hand on experiences as they perform varied type of activities like analysis of task or field work.

Nyong (1984) has concluded that conditions of the laboratories play an important role in students’ achievement. As in schools where well-equipped laboratories are found students of those schools have better results in the school certificate science examinations than those they had ill-equipped one.

A textbook plays an indispensable role in academic achievement of students. It was explored by many researchers (Heyneman and Loxley, 1982; Walberg, 1984; Beeby, 1986) that textbook and academic achievement has a significant co-relation.

Nwachukwu (1984) exposed that due to inadequacy of laboratory resources there is difficulty for teachers to conduct experiments. It was found that teaching of Biology practical was difficult and the students learning experiences was limited when laboratory resources were insufficient.

Fuller (1985) conducted a study regarding textbook availability and its usage it was concluded that students who had used more than two textbooks scored more marks in exams as compared to the students who had not used textbooks. Further it was explored that availability of text books in the library and its usage is also correlated with students’ performance. Fuller (1986) also identified that library is an important instructional media and the pupils’ achievement is significantly influenced by it.

Ango (1986) concluded that laboratory work is very much helpful in stimulating students’ as they perform lots of useful scientific activities and experimentation and
their basic skills are enhanced through laboratory work and it also promote students’ long term memory.

Akinwumiju and Orimoloye (1987) and Obilade (1989) unveiled that when there is non availability of resources like books, teaching aids and educational materials and if available and are grossly insufficient, under utilized and poorly managed it results into the poor performance of students as well as teachers.

Arubayi (1987) conducted a study taking into consideration the multiple variables like, laboratory facilities, textbooks availability, number of science books in the library and qualification of teachers. A significant relationship was observed between all the variables.

Popoola (1989) discovered that well equipped library has positive co relation with the academic achievement. Schools which restrain well equipped library, their students usually acquired high academic achievement.

Odulaja and Ogunwemimo (1989) highlighted that students’ performance is affected by varied factors like methodology adopted for both teaching and lab work, laboratories’ condition, availability of resources for classroom processes, strength of students as well teachers.

Ola (1990) opined that a well equipped library is a major facility which enhances good learning and achievement of high educational standard.

World Bank publication (1990) citing Mwamwenda and Mwamwenda (1987) reported about survey conducted in 51 primary schools in Botswana and concluded that when adequate facilities pertaining to classroom like desks and books are provided students performed in better ways in the academic tests.

Laboratory provides a platform for the learners to exercise his believes, ideas, statements, theoretical propositions, principles etc. via experimentation (Soyibo, 1990).

Adesina (1990) asserted that adequate provision of school facilities in relation to the students’ population is important because the quality of education that our children receive is affected by the availability or non-availability of physical facilities.

Hallak (1990) established that, facilities form one of the potent factors that contribute to academic achievement in the school system. It was further substantiated that their availability, relevance and adequacy also contribute to academic achievement.
Lowe (1990) established that the ability to control classroom temperature is crucial to the effective performance of both students and teachers. Kovol (1991) examined the relationship of classroom physical features to the learning environment and found significance for every factor examined.

OECD (1992) concluded that the introduction of educational technology needs to be analyzed for each space as the equipment takes up space and demands electricity and special wiring for networking further added the use of e-mail to create virtual schools is beginning to happen, and will spread rapidly.

It is concluded in many studies that textbooks play a vital role in students’ performance and these are the store house of information and knowledge both for the students and teachers. Oni (1992) conducted a study on the academic performance and recommended textbooks; a significant relationship was established between the same.

Gamoran (1992) explored in one of his study that physical facilities, salary of teachers, availability of books in the library and the presence of science laboratory, have significant impact on students’ achievement one of the variables background of the students was also taken into account.

ICT has potential to generate interest, motivate and attract learners. Wang, Haertel, and Walber (1993) conducted an extensive Meta analysis on school learning and substantiated that there exists a positive relationship between the learner and the environment provided for learning. It was also explored that the availability and non availability of computers at home also matters.

Aliyu’s (1993) in one of the finding established that there is no significant difference in the academic achievement of the secondary schools students with or without adequate instructional facilities. However, it was also corroborated that instructional facilities are very essential for students’ academic achievement for particular subjects.

London (1993) explored that in some of the developing nations, some schools are lacking required physical facilities and there are some cases where facilities are available but are of sub standard quality. It is matter of very much consideration, alarming and crucial that positive relation is found between the quality of facilities and academic achievement. The researchers (Wilcockson, 1994; Lawal 1995 and Ajayi,
1996) identified the significance of facilities in teaching learning process. It was revealed that the absence of educational facilities whether in deteriorating or of poor quality affect the academic performance of the students.

Earthman and Lemasters (1996) have pointed out that students surrounded by a safe, modern and environmentally controlled environment experience a positive effect on their learning. Writing on the situation of our secondary schools, Okoli (1995) reported that laboratories have become shelves of empty bottles of chemicals. Hines (1996) identified building age, windows, floor condition, heat and air conditioning, exterior painting, cleanliness, wall color etc effected students’ achievement.

Chan (1996) concluded that for the improvement of students’ performance their need and instructional entity must be assessed and must be suitably placed and designed. In terms of academic achievement, Soyibo (1996) and corroborating this, Gana (1997) reiterated that students instructed entirely by the laboratory methods had higher attitude scores but lower achievement scores than students instructed entirely by the traditional lecture or textbook mode.

Hsi and Hoadly (1997) concluded that ICT usage have benefit for disadvantaged groups the major gain regards to equity is that digital communication can engender the promotion of a more equitable participation.

Fabunmi (1997) asserted that school facilities, when provided will aid teaching learning programme and consequently improve academic achievement of students.

Farombi (1998) argued the saying that “seeing is believing” when usage and effectiveness of lab work for teaching of science was observed it was inferred that students have more understanding when they perform as compared to when they are only informed. The success of teaching of science basically lies on the facilities dispensed in the labs as well as usage of these facilities.

Johnson (1998) established that instructional materials’ availability and usage is significantly co-related with students’ academic achievement. It was also corroborated that inadequate availability and usage of instructional material significantly effects the students’ achievement.

Libraries are said to be the power house of schools. There are many schools in which there is no library facility (Shodimu, 1998) whereas Ogunseye (1986) noted that
total absence of an organized school library will result into low and poor academic performance as well as will not produce self learners.

“Technology is the inescapable companion of the 21st century citizen” (Day and Spoor, 1998) noted that the infusion of technology into the educational program had significant impact on the students and teachers.

Main importance is to be given to the design of the physical facilities for learning as the design of the physical facilities also affects the performance of the students. Blair (1998) observed that a be positive correlation exist between the design of facility and learning.

Olubor (1998) revealed that lack of adequate facilities such as textbooks, ill-equipped classrooms, laboratories, workshops and library are among the probable causes of student’s poor performance in examinations.

Farombi (1998) reiterated that school libraries may not be effective if the books therein are not adequate and up-to-date as its impact may only be meaningful if the library could be opened to the students always for a considerable length of time in a school day.

Jago and Tanner (1999) unveiled that adequate lighting and appropriate colour choices play a significant role in the achievement of students, affecting their ability to interpret the written word and their attention span.

Becta (2001) substantiated that significant differences were found in science attainment of students, between the students of those schools where there was well managed and good quality of ICT resources and in those where there was poorly managed low quality of ICT resources existed.

Yadar (2001) opined that no course in science and mathematics can be considered as complete without including some practical work.

It was established in the study conducted by Day (2001) that flexible space in the classroom allows to have more student- students and teacher student interactions in participatory learning activities. Classroom size and flexible interiors of the class gives opportunities to teachers to adopt modern educational strategies like project based learning and interactive laboratories, multiple group formation and individualized investigation.
Schneider (2002) inferred that there is considerable empirical support for the argument that a variety of sustainable design characteristics that can have a significant influence on student behaviour and academic achievement.

Availability of various type hardware and software increases the opportunities for teachers to use, modify and vary instructions according to the learners’ needs and learning style. Varied type of available tools like video and amplification system, interactive boards allow the teachers to deal with varying capabilities and varied learning styled learners. (Milshtein, 2003). Bandele (2003) noted that the importance of physical facilities cannot be relegated

Danesy (2004) complimenting environmental and socio-economic factors to produce high academic achievements and performance include good teaching, counseling, good administration, good seating arrangement and good building.

Chamnan (2004) tried to access in the secondary schools, the utilization as well as availability of resources. It was established that educational resources both in the classrooms and laboratory are scarce in most of the schools, if resources are existing all were not in workable condition and out of theses the modern equipment were found to be more in non workable condition as compared to traditional one due to non availability of skillful persons to operate them. Further, the deficient number of software as well infrastructure was also observed. In big sized schools the more high tech resources were observed as compared to the small sized ones. Regarding utilization of the educational resources 50% of teachers showed their satisfaction.

Facilities like modern laboratories, libraries and classrooms are to be put in place in all our schools. Adesola (2005) found out that the level of available resources is indeed a plus point to the teachers and goes to show the level of ingenuity and commitment of the teachers toward effective delivery of lesson.

The study undertaken by Shami and Hussain (2005) revealed that the availability of physical facilities in a school had a significance impact on students’ performance. In the context to school facilities, environment in which the students learn is very crucial and without the suitable environment effective learning can not take place.
Dwyer et al. (2005) divulged that the use of computers and internet can deliberately provide learning outcomes to their students. However, the most common problem that may arise is the protection and security of the users (both students and teachers) in viewing the networking sites.

Edyburn (2006) disclosed that the collaboration of technology and teaching among the schools can be a good start in academic performance.

Bruce (2006) claimed that the indoor and outdoor environments should complement rather than duplicate each other. Simple and safe facilities, equipment, and furnishings permit freedom of activity and provide provision for creativity on the part of the child. Kang (2007) unveiled that addition to the educational investments like, providing physical facilities can strongly contribute to increase the academic performance of the students.

It was acknowledged by Ajayi (2008) ICT based facilities involve audio and video conferencing, CAI, computer based feedback and network operation like internet/websites. Further it was also established that, it must be taken into consideration that the effective use of ICT based methods in classroom processes largely rely on the competency of teachers in using the ICT and availability of ICT resources.

In the discipline like science and mathematics practical work is regarded as of utmost importance (UNESCO, 2008). Different studies conducted by Ayodele (2000) and Vandiver (2011) showed that a positive relationship exists between availability of facilities and student academic performances.

The above studies have proven that physical facilities for teaching of science whether human or non human are the most persuasive factor of academic achievement. Physical facilities pertaining to laboratory, library, infrastructure, administrations, classroom and above all ICT and the likes are very much essential and crucial for high academic performance.

There is no doubt, that the function and availability of facilities to students is an important factor in achieving academic excellence. But intelligence of students also plays crucial role for academic achievement.
1.12. INTELLIGENCE

The term intelligence is indistinct, blurry, ambiguous and unclear in its meaning. Varied psychologists of India as well as of abroad have been construing the term in diverse modes and they are in concord on the meaning of the term intelligence. Since last 70 years many researches have been finished in the assorted field of subject of intelligence including the meaning and nature of intelligence. In psychological text, intelligence has been treated as a paradigm which no one knows what intelligence is. In this regard E. Hine says “Intelligence is that which cannot be defined.” There is no end to the definitions of intelligence just as there is no end to the definitions of education, life, love and God”. Many questions like, is intelligence a single ability or a mishmash of numerous different abilities. Can a person be extremely intelligent in some respect but below average in others? It is therefore, apparent how a difficult, inexact and inaccurate concept of intelligence is due to the indistinctness.

Intelligence is a very general mental capability that, among other aspects, involves the ability to reason, plan, decipher problems, reflect conceptually, comprehend complex ideas, learn quickly and learn from experience.

A person’s intelligence comes from a combination of nature (genes) and nurture. For many years, psychologists studying the human brain/mind have tried to measure its capabilities. Quite a bit of this work has focused on defining intelligence and measuring a person’s intelligence. The concept that intelligence could be or should be tested began with a nineteenth-century. After the shake-up from the 1859 publishing of Charles Darwin's “The Origin of Species,” Intelligence is complex use of creativity. Intelligence is a property of mind that encompasses many related mental abilities, such as the capacities to reason, plan, solve problem, think abstractly, comprehend ideas and language and learn. According to John Kotter intelligence is “a keen mind i.e., strong analytical ability, good judgment, and the capacity to think strategically and multi-dimensionally”.

“Intelligence is the aggregate or global capacity of the individual to act purposefully, to think rationally and to deal effectively with his environment (Wechsler, 1944).” It is global because it characterizes the individual’s behavior as a whole; it is
an aggregate because it is composed of elements or abilities which, though not entirely independent, are qualitatively differentiable.

Intelligence is also regarded as mental competence which includes the comprehension of complex phenomenon; learn from experiences, abstract thinking, quick learning, reasoning ability, planning ability, problem solving ability and several other intellectual capabilities. It is not merely book learning, a narrow academic skill, or test-taking smarts. Rather, it reflects a broader and deeper capability for comprehending our surroundings—"catching on", "making sense" of things, or "figuring out" what to do.

Briggs (1962), Mitchell (1963) and Keller (1964) found that intelligence was major factor influencing academic achievement. Torrance (1965) concluded that more intelligent children with more capabilities are likely to accomplish more on academic tasks. Singh (1965) reported academic achievement and intelligence were significantly related beyond the 0.01 level of confidence. Guilford (1967) gave SOI model. Lewis (1968) found intelligence and achievement to be highly correlated. Berman (1970) found that expects only high achievement in final high school examination correlated significantly with high I.Q. Tyler (1974) pointed out that more intelligent children tend to get better grade in school, remain in school longer and have more positive attitude towards school. Srivastava (1974) found that intelligence is significantly correlated with academic achievement at 0.01 level of confidence. Seetha (1975) reported that high achievers possessed superior intelligence when compared with low and non-achievers. Contractor (1977) found that I.Q. was positively related with educational attainment.

A frequently used operational definition of intelligence is “intelligence is what intelligence test measures” After the invention of intelligence test plenty of research has been conducted to establish empirically the relevance of intellectual abilities for variation in academic performance.

In 1983, Kulik, Bangert, and Williams analyzed studies on the effects of computer-based teaching on secondary students in mathematics and science and unveiled that students with computer-based teaching scored better in final examinations than did students in conventionally taught classes.

Specialized computer programs were found to help in developing inquiry skills and also increasing scientific knowledge even when strong misconceptions were
presented at the start of the lesson (Shute and Bonar, 1986). Niedderer et. Al. (1991) established that there is consistent evidence from the earliest days of educational ICT that when pupils are given autonomy to derive and test their own ideas and understanding, their ways of learning change, and there is improvement in their understanding and achievement.

Mayer and Anderson (1992) studied on the instructive animation which helped students to perform better than learners who did not experienced any animations. Webb (1992) in one of his study, concluded that students learn with logical strategies for categorizing scientific processes when the quality of construction of qualitative models measured with the help of software. Moreover the students constructed the models successfully when they were provided with ICT based facilities. Rose (1992) conducted a study on effectiveness of computer assisted instruction with special reference to underachievers. It was found that CAI was more effective than without CAI for underachievers further it was concluded that there was no relationship between the post-treatment scores when the variables like gender, locale and achievement level of the experimental group. But for the variables I.Q., study habits and math study attitude, the positive relationship between the achievements at the pre-treatment level was found.

In the first Impact project (Watson, 1993) the varied type of methods were adopted, like one of the ICT tool Boolean logical operators a data-handling software was used to analyze the scientific data to study the effect of ICT on learner’s ability by pre- and post- tests scores. It was found that more advanced data-analysis skills was observed in those students who had used the computer database package.

Nakhleh (1993) studied about ICT employed and non ICT employed chemistry experiments and concluded that both could be beneficial to facilitate scientific learning. Boohan (1994) furnished that by using ICT in science, pupils develop novel strategies for problem solving like building models and creating new rules.

Mellar et. al. (1994) inferred that with the help of new technologies students has developed new ways of learning reasoning, hypothesizing, representation, building of new knowledge etc. and this has resulted in the development of new mental models of learning.
Williamson and Abraham (1995) conducted a study and acquired the support of atomic and molecular behavior simulators in a chemistry course. It was found that the simulations increased the conceptual understanding by helping students from their own dynamic mental models.

Cheney (1996) found that with the usage of CAI the learner’s knowledge get increased as multiple senses are used for this. Moreover learners have durable knowledge when the text combined with sound, graphics and video. Berson (1996) concluded that by using internet, students can gain access to expansive knowledge links and can broaden their exposure to diverse people and perspectives.

Taylor et al. (1997) divulged that pupils’ cognitive skills got honed when they were taught via modeling method to clear the concept of science. Basically in the initial years science was the main subject in which ICT was used as it was the site of varied discoveries and innovations. Tindall Ford, Chandler, and Sweller (1997) studied whether two sensory modes are better than one. The aim of this study was to explore effect of multimedia instructional experiences upon the learner’s cognitive-load and learning performance. It was concluded that learners exposed to multimedia instructional activities, displayed superior learning performance compared to learners who experienced instructional activities presented in visual formats.

Christmann et. al. (1997) while conducting a study on the secondary leveled students and also, used previous research data to indicated that the pupils who were receiving CAI have higher academic scores than those who were taught via traditional instruction further it was observed that achievement in science subjects was more than the other subjects.

Fletcher (1998) conducted a study on Computer Assisted Instruction program and compared the achievement of students who used Computer assisted instruction and the students who had not used Computer assisted instruction. It was found that Computer assisted instruction group made significant gains when compared to Non-Computer Assisted Instruction Group.

Huppert et al. (1998) conducted an experimental study to see the effect of computer simulations on pupils’ ability. The post-test results on academic achievement
indicated that pupils in the experimental group achieved significantly higher mean scores than the control group.

Hennessy (1999) exposed that the use of ICT, changes the relative emphasis of scientific skills and thinking. Numerous studies have concluded that no clear differences in attainment or achievement in science between classes making more use of ICT and those using less ICT (Alspaugh, 1999) are seen.

Tao and Gunstone (1999) revealed that pupils built and complemented each other’s idea and shared common understanding when they were taught physics for ten weeks in a simulation mode. Davelsbergh et al., Henderson et al. (2000) investigated that use of micro world simulation fetched improvement in the science students regarding recall, higher order thinking skills, usage of scientific language and conclusion drawing skills.

Varied researches were reviewed and carried out over the past two decades by Cox (2000), on the educational use of ICT-based simulations and modelling, and concluded that the main contribution made by ICT was regarding pupils’ understanding of science by the acquisition of investigative skills and improved understanding of scientific concepts and processes.

Linn and His (20000) in their study developed ICT integrated pedagogies for the science curriculum concluded that there was substantial improvement in problem solving and inquiry skills and also in understanding the scientific concepts when ICT was integrated for imparting science instruction.

Chang CY (2000) studied about CAI effectiveness for teaching earth science concepts. The findings of this study showed that CAI was superior in promoting students' learning, knowledge and comprehension of concepts as compared to without CAI.

ICT used as a tool in science teaching and learning can increase students’ concentration, communication, metacognition, motivation and creativity (Becta, 2001; Leask and Pachler, 1999; Monteith, 1998).

Desai (2001) traced recent trends in effectiveness of Programmed Learning in teaching of physics in IX grade. It was found that programmed learning approach proved better than the lecture method in the study of physics and pupils scoring high on
the intelligence test also scored high in the post test and pre test and those having low scores on the intelligence test scored low on the post test.

Sanjna (2001) conducted a comparative study on the effectiveness of CAI and CMI on Pupil’s achievement in Science, both CAI and CMI were found significantly supportive in achievement of science students. Further it was also reiterated that self concept more involvement of the students was recorded in science.

Some experimental studies have shown that computer simulations can be as effective as the real activity in teaching science concepts and improving scientific understanding across a variety of topics (Huppert, Lomask and Lazarowitz and Trindade, 2002). A study on the effectiveness of computer science instruction, (Permar, 2002) furnished that the achievement of rural area students in computer science practical has been found to be significantly higher than the mean achievement of urban area students.

Ardac and Akaygun (2004) established that computer technology can be used for cartoon spaces, symbols and interactions of molecular representations to help students to understand more abstract ideas and chemical phenomena. In an other study effectiveness of multimedia-based instruction that emphasized molecular representations on students’ understanding of chemical change found that learners who received software delivered multimedia instruction performed well when compared to the traditional instruction group in both recall and maintenance post tests.

Researchers (Kozma, 2005; Webb and Cox, 2004 and Kulik, 2003) demonstrated that ICT can help to deepen students’ content knowledge, engage them in constructing their own knowledge, and support the development of complex thinking skills.

Barak and Dori (2005) concluded that in real sciences, there are three approaches to new knowledge: theoretical, experimental and computational. One interesting example which has come from computational chemistry to science education is visualization of chemical compounds and reactions. There is evidence that use of visualization tools in problem solving enhance conceptual understanding among students.
Jones (2007) concluded that Virtual Learning Environment (VLE) can increase student’s motivation and the understanding of the subject matter. Further it was concluded that students’ beliefs may hinder their learning experience, while maintaining an effective social-interactive environment, can help them to understand subject-specific concepts.

It has been reported that teachers appear to have difficulty with creating classroom environments in which students are supported in creating their own constructions of knowledge through the use of ICT tools (Koehler, Mishra, and Yahya, 2007).

Alev (2007) found that computer assisted instruction is more feasible than the traditional approach in terms of cognitive and affective behaviors. Students’ perceptions before and after the application of CAI have significantly changed. Computer-based learning has the potential to facilitate development of students’ decision-making and problem-solving skills, data-processing skills, and communication capabilities.

Butler and Lumpe (2008) evaluated the use of Scaffolding Software and its relationships with motivation and conceptual understanding. The study was designed to know significant relationships between the scaffolding features represented in the software and students’ motivation and conceptual understanding of photosynthesis topic. The correlation supported the assumption that there is a positive relationship between the student use of the maintenance features and student conceptual understanding of photosynthesis topic.

Kara (2008) investigated, the retention effect of computer assisted instruction on students’ academic achievement for teaching the topic Force and Pressure. It was concluded that significant differences existed between the science subject test scores of experiment and control group.

Dalacosta et al. (2009) conducted a study on multimedia application with animated cartoons for teaching science in elementary education. The findings on the use of animated cartoons in a multimedia application meant to evaluate their effectiveness in supporting teaching and learning in science. The results provided evidence that the use of animated cartoons significantly increases the young students’ knowledge and
understanding of specific science concepts, which are normally difficult to comprehend and often cause misconceptions to them.

Ferguson, Whitelock, and Littleton (2010) divulged that ICTs can be very helpful in communicating and representing ideas in science. Visual ICTs have the potential to overcome some of the challenges by zooming in or out, or speeding up and slowing down a phenomenon. They can be particularly useful if they are not used as finished products but are seen as “improvable objects” where students can add or manipulate aspects that clarify and extend their ideas and thinking.

Uplane, Sonawane and Padmini (2011) conducted a study on CAI: An effective instructional method for secondary school low achiever. The study found that there is significant difference in the mean achievement scores obtained in the pretest and posttest obtained by low achievers in physics of VIII standards. The performance of students in posttest and retention-test for questions on ‘Physics content’ was better than in pretest.

Above studies provide corroborating evidence about the effect of ICT on students' knowledge, understanding, learning, analysis and synthesizing of scientific concepts in an efficient way. Eventually ICT has effectiveness on the intelligence level of the students.

ICT based teaching environment effects drastically on student’s intelligence level, there is another imperative factors which is accountable for the achievement in science subject is the interest of the students.

1.13 INTEREST IN SCIENCE

“No use to shout at them to pay attention. If the situations, the materials, the problems before the child do not interest him, his attention will slip off to what does interest him, and no amount of exhortation of threats will bring it back.” -John Holt

Interest is one of the important traits of the personality of an individual, which have significance for educational and vocational success and satisfaction. These traits are manifested as likes dislikes, indifferences, preferences and evaluation.

Interest has no clear definition at one extreme it is the causal liking or disliking directed towards a single object, person’s idea or job level. At the other extreme it is the definition in which interest are structured out of the individual attempts to match his self
estimate with the competitive reality or job and activities in which he chooses to engage
or is formed to engage.

According to Strong (1943), “Interests are the sum total of likes and dislikes for
wide range of stimulus, objects and activities”.

According to Bingham (1937), “An interest is a tendency to become absorbed in
an experience and to continue it”. According to Murphy “interests are conditioned
stimuli related to goal objects and expressed as likes or dislikes of activities, objects,
characteristics, or people in the environment that means that interest is an activity of
moving towards or away from the object or activity.”

Interest generation and motivation are considered as very important learning outcomes.
If teachers are able to do the same the desired learning outcomes are inevitably
achieved. So teachers should plan such type of activities in the classroom so that
students should feel motivated and interested to learn, with the advent of this students
will show excessive interest of learning as they will enjoy learning activities, value their
educational endeavors, and perhaps even seek out similar educational experiences in the
future. Interest has been defined as a particular relation between a person and a content
area (e.g., task, topic, or domain) that is characterized by focused attention and
heightened engagement.

Gay and Greschler (1994) did a comparison between immersive groups using
Virtual Learning Environment (VLE) and non-immersive treatment groups specially
designed to teach children about the structure and function of cells, the immersive
subjects demonstrated better retention of symbolic information, and further more
interest was observed in the students who were provided Virtual Learning Environment
(VLE) experience.

Cox (1997) listed a series of benefits of using ICT in lessons out of which one is
enhanced enjoyment and interest in learning the subject. Osborne and Collins (2000)
exposed that students may be motivated to learn science because using ICT may give
them opportunities to have more control over their own learning by allowing them to
study the topics they are interested in and that are relevant to their own lives.

Newton and Rogers (2001) after reviewing varied researches inferred that there
is considerable evidence that learners are highly motivated when their learning is
supported by ICT. Osborne and Hennessy (2001) reported that ICT enhances the effectiveness of information presentation and also stimulates students’ interest.

Earl (2002) established that using ICT in different activities that simulated the real world had given students opportunities to increase their motivation and improve their attitudes toward the subject and their interest in learning. The results from Bett’s study (2003) suggested that ICT can motivate students and enhance the quality of learning where its use is tailored to lesson objectives and the specific needs of the students.

McFarlane and Friedler (2003) studied the motivational effect of portable computers and established a positive effect on student’s motivation. However, despite of teachers’ perceptions about the motivational effect of ICT alone cannot sustain the motivation to use computers. Rather it is the teacher who use and integrate ICT into the curriculum that plays a pivotal role in keeping students motivated. Dori, Barak and Adir (2003) found that ICT enhanced learning motivates and engage students for learning.

Rosas, et al. (2003) authenticated that computer games make learning meaningful and create a learning culture that is more in correspondence with student’s interests. Researcher had found that ICT tools effectively promote pupils’ interest in learning science. Further it was established that ICT involving sight, sound, movement or animations can maximizes pupil’s interest.

The research done by Kajee (2004) found that researchers based on ICT believe that ICT would harmonize the teaching and learning environment as well as promote equal participation among the students.

Trimmel and Bachman (2004) studied the impact of introducing laptops into classrooms and one of their conclusions was that information technology has a positive impact on school attendance and learner’s interest.

Sefyrin (2005) and Jackson, Ervin, Gardner, and Schmitt (2001) divulged that competence in ICT could be seen as a question of interest in ICT, where men are more interested in ICT than women. Denby and Campbell (2005) recognized that, with ICT students are more engaged in activities, they show increased interest and longer attention span.
Korakakis et. al. (2009) examined the use of specific types of visualization (3D illustration, 3D animation, and interactive 3D animation) combined with narration and text, contributing to the learning process of students in science courses. The results indicated that multimedia applications with interactive 3D animations increased the interest of students and made the material more appealing to them.

It is apparent from the above that several claims have been made in the literature regarding the effectiveness of Information and Communication Technologies (ICT) on pupil’s interest, leading them to have a more interest in their work, spend longer time on tasks and have more commitment to their learning. As interest is an essential entity for attitude formation it becomes necessity, compulsion and binding to study the effect of ICT based teaching environment on the attitude of the students.

1.14 ATTITUDE TOWARDS INSTRUCTIONAL MEDIA

Freeman defined attitude as “A dispositional readiness to respond to certain situations, person, objects or idea in a consistent manner, which has been learned and has one’s typical mode of response.”

Attitude is a specific mental state of an individual towards something, according to which his behavior towards it is molded. It is a tendency to react in certain way towards a designated class of stimuli.

It was supported by many researchers (Allport, 1935 and Oskamp, 1977) that students who are positively inclined toward tasks or subject matter are likely to learn more and also learn more easily. For this reason, student attitudes toward computer use could have an impact on their learning. Thurston (1946), defines an attitude as “the degree of psychological event”

An individual who has associated positive effect or feeling with some psychological object is said to like the object or to have a favorable attitude towards the object. An individual who has associated negative effect or feeling with some psychological object is said to dislike the object or to have an unfavorable attitude towards the object. An attitude may be defined as a learned disposition to respond consistently in a positive or negative way to some person, object or stimulation. (Petty, Ostrom and Brock, 1981)
Blanchard (1975) found no pattern of relationship between achievement and attitudinal data. Breckler (1984) viewed attitude as a hypothetical response to an object and regarded its affect, on cognitive behaviour in which attitude was expressed in observable responses.

The earliest research that examined attitudes toward computers was conducted by Lee (1970) and two dimensions of attitude were identified: (i) the beliefs in the computer as a beneficial tool and (ii) beliefs that the computers are autonomous entities.

When an individual has both affective and conative influenced response for some individual, event or object with a negative or positive state of mind or sentiment is called attitude. Attitude is learned, acquired, developed or organized with experience (Ajzen and Fishbein, 1980).

Society views computers as highly technical and is a part of a male domain (Campbell and Mc Gabe, 1984). Haunsel and Hill (1989) found out that pupils using computers had more positive attitude towards biology and natural sciences than pupils who were educated by traditional styles. Several studies found gender differences in attitudes toward ICT.

Price (1989) conducted an attitude survey and observed that student progress in a middle school science project where CAI was used as a tutorial and research tool. It was concluded that the use of CAI in this way encouraged an overall improvement in motivation and interest in the science research project. Winfred (1991) quoted in his study that initial computer experiences may play role in the formation of computer attitude. Park (1993) in his study Co-operative Learning and Individual Learning with Computer Assisted Instruction in an introductory University level Chemistry course established that the majority of the students in the university level showed positive cooperation on group work and positive attitude toward using computers in the classroom.

It was generalized by Kaplan (1994) that when personal computers (PCs) are used by female they find that computer using is fun. Male, on the other hand use the computer to get mastery over the commands they want to own that type of computers which have special features like voice recognition and features that extend their senses. Basically men wanted to command the machines and women to be able to use the machines.
Younger pupils, boys and girls have more positive attitudes toward computers than the older (Comber, Colley, Hargreaves, and Dorn, 1997; Laguna and Babcock, 1997). Yu (1998) found that computer assisted instruction increase students’ performance and attitudes towards science. Winter, Chudoba, and Gutek (1998) found a correlation between attitude toward technology and number of hours spent in using computer.

Brosnan (1998) explored that 6 to 11 years old boys had more positive attitudes towards computers than girls. The successful integration of computers in educational environments depends, to a great extent, on teachers’ and students’ attitudes towards the computers (Selwyn, 1999). Researchers intended to find out the attitude of females towards usage of ICT. Ray, Sormunen, and Harris (1999) it was established that women have positive attitude towards the use of computers than men. Further it was also asserted by females that ICT increase productivity by simplifying the tasks. Women were found to be more comfortable in technology usage.

Pupils’ attitudes towards computer exercises were highly positive (Ogilvie, Trusk and Blue, 1999) and additionally, most of students worked at their own speed and with that their computer literacy got improved.

McKinnon, Nolan, and Sinclair (2000) found that students in their experimental group became enthusiastic computer users and performed significantly better compared to the ones in the non-experimental group. Smith, Caputi and Rawstorne (2000) revealed that computer or ICT attitude has been defined as a person’s general evaluation or feeling of favor or antipathy toward computer technologies and specific computer related activities. Computer attitude evaluation usually encompasses statements that examine user’s interaction with computer hardware, computer software, other persons relating to computers, and activities that involve computer use.

Rothman (2000) in his study examined the impact of computer-based science instruction on content achievement, attitude about learning, critical inquiry skills and level of cognition. Study concluded that nontraditional, computer-based instruction in science significantly improved the students’ attitudes toward science learning.
Bozionelos (2001) exposed that there are many studies, where it is reported, that older students have more positive attitudes to computers than the younger.

It is believed all over the world that technology is more appreciated by the boys as they are seen more concerned and connected towards it. It is also practiced by the society that technological knowledge is more encouraged for boys as compared to girls (Clegg, 2001; Facer, Sutherland and Furlong, 2001).

Cooper and Brna (2002) reported evidence that pleasure and variety keep students engaged and motivated. Further it was concluded that if ICT is carefully planned and pedagogically implemented, it can support relationships and motivation that in turn support long-lasting engagement and learning.

Murphy and Beggs (2003) carried out an extensive survey of children’s attitudes to science and found that most of the older pupils (10-11 years) had significantly less positive attitudes than younger ones (8-9 years) towards science enjoyment, even though the older pupils were more confident about their ability to do science.

Lim and Tay (2003) unveiled that by using the Virtual Learning Environment students were not only engaged in the learning tasks, but also willing to spend more time on learning and hence developed a positive attitude towards learning. Additionally, they could also develop other skills like communication, social and higher order thinking.

Dorup (2004) found males had more access to computers at home, and held more favorable attitudes towards the use of computers in their studies as compared to females.

Passey, Rogers, McHugh, Allaway (2004) conducted a study on the motivational effect of ICT on pupils to investigate the effects of ICT on pupils’ motivation. This study has found that ICT positively impacted on motivation, particularly in relation to engagement, research, writing and editing and presentation. Pupils reported that the Internet, interactive whiteboards, writing and publishing software, and presentational software were the most useful. There was also evidence that ICT positively influenced attitudes towards school work and school behaviour.

A study Effectiveness of CAI in Biology at secondary school level (Pandian, 2004) made public that the CAI students demonstrated significantly higher achievement
gains in biology. The variables self-esteem, attitude towards Biology and computer were also influenced by the CAI.

The study of Palaigeorgiou, Siozos, Konstantakis, and Tsoukalas (2005) confirmed that both men and women had similar engagement with computers and had concerns for the future effects of continuous computer use, but women were more anxious about hardware usage, and judged the consequences of computers in personal and social life.

The research findings of Girl and Tan (2005) and Chan (2002) in the meta-analytical research studies indicated that computer assisted lessons can improve students’ academic achievement and attitudes toward learning, and allow students to learn more in less time with more enthusiasm.

Boys use computers more for playing and recreational purposes, they are more interested in hardware, and they take on more independent challenges for learning computers and ICT than girls do (Papastergiou and Solomonidou, 2005; Hakkarainen et al., 2000).

Mizrachi and Shoham (2004) and Shashaani (1997) pointed out, that more interest was shown by boys in the usage of computers as compared to girls and more over boys have better ICT and computer skills. In relation to attitude towards computer it was found that boys use computers more in their leisure time, and their attitudes toward computers are more positive than the attitudes of girls.

Tekbiyik and Silk (2007) documented that CAI has varied effects on students such as academic achievement and attitudes toward course. Students’ attitudes are one of the key factors in learning science. Learning process is important in improving positive attitude. Female have negative attitude towards computer (Bebetsos and Antoniou, 2008), they are often less computer literate than males and this may result in different ways of using the computer.

From the exceeding it can be corroborated that when ICT is used for imparting instructions there is change in students ‘attitude and they spent more time in learning. Further studies are also revealing that there is gender difference in the usage of computer.
1.15. ICT VS TRADITIONAL TEACHING

In traditional form of teaching, teacher acts as a just guide for imaginative and exploratory thinking and his role is regarding specifying learning objectives, preparing learning activities, and designing assessment. But in ICT based learning environment teacher acts as a friend, philosopher, guide and a facilitator of knowledge more over also provide opportunities for students’ to construct new knowledge.

ICT based teaching techniques work well in various instructional settings, but many teachers remain skeptical because there is lack of qualitative data supporting for the same. Travis and Lord (2004) investigated to compare undergraduate non-majors biology lab section taught in a traditional-centered style to a similar section taught with ICT based instructions. The result showed many significant differences between the groups and demonstrated that the ICT based class had higher quiz scores, more appreciation of science, better attendance, and increased participating in the lab activities than the traditional group.

In the present study instead of traditional method constructivist approach of teaching was adopted as Orogbu (2007) in article “Traditional Teaching vs. Constructivist” states that constructivist teaching emphasis on learning based on pace of students by using hands on activities. Unlike traditional teaching, constructivists do not teach but encourage children to explore and think themselves. So, constructivist teaching is considered more effective and efficient in making learners to learn through means of mental construction.

According to study conducted by Khalid and Azeem (2012) where experimental group was taught with constructivist approach and control group being taught with traditional method. The result showed in favor of experimental group indicating the effectiveness of constructivist approach of teaching in terms of academic achievement.

Traditional approach is very common in teaching. It ignores the students and subjects need through use of no innovative activities and knowledge acquisition. Many researches indicated that there is positive relationship between Constructivist approaches of teaching and achievement. Constructivist approach is given high regard comparing to traditional method of teaching as it is observed more effective.
If combination of both ICT based method of teaching embedded with constructivist approach is employed, definitely, it will result in higher level of achievement as constructivist environment gives large opportunities to embed ICT in classroom processes.

1.16 EMERGENCE OF THE PROBLEM

In review of literature several findings, which were conducted with varied variables on diverse age group pupils in varied situations several years earlier, are compared, related or paralleled. All the findings, publications, etc. can not be reviewed or compared due to scarcity of time but the comparison or relation established with the accessible findings contribute a lot in the conduction of research. Main findings from the studies are pertaining to:

i. Effect on achievement between uses of certain ICT based tools and resources.

ii. Positive effect of ICT on science attainment.

iii. Science education based research has comprised findings of pupils’ misconceptions and alternative frameworks. There is varied type of delusions regarding the type of pedagogical strategies and resources are to be adopted to understand the learners’ misconceptions about science and what type of misconceptions are existing.

Problems and difficulties of learning had enabled the researchers and developers to innovate software that deals with the learning difficulties.

The attainment effect can be measured in ICT generated environments, as the nature and services of many ICT tools and services is content specific. The reliable and valid measurement of effectiveness of ICT usage in simulated and modeling environment designed for specific learners has been developed by varied researchers. It is observed that there is a significant and positive effect of ICT based learning environment on the learners’ related to conceptual understanding of scientific concepts.

It is direly demanded from the today’s teachers to be fully equipped with the usage and knowledge of ICT based tools and resources, expertise and effectiveness in teaching methodologies, capacity to assist students to meet petition of the emerging knowledge to improve and enrich the quality of learning. It is observed that usage of ICT in the science curriculum is scarce, it is not as per demand and desired, as it should
be used extensively. It was also corroborated that very sparse studies are conducted on the effectiveness of ICT mediated instructions on the achievement of the students in science in relation to physical facilities, intelligence, interest and attitude of the students. Whether ICT also supports constructivist pedagogy, wherein students use technology to explore and reach an understanding of scientific concepts. Investigator developed ICT based teaching package and intended to find the effectiveness of ICT mediated instructions in science at Secondary stage.

1.17 SIGNIFICANCE OF THE STUDY

There are infinite ways to impart instructions, differential type of ICT based pedagogical strategies and tools are extensively adopted by the teachers due to their effectiveness. However there is no particular destined, defined and standardized as the excellent mode of imparting instructions for information or knowledge transmission. Due to massive explosion of ICT based tools and services for education delivery, novel form of education is conceived. Institutions are spending enormous amount of money on ICT infrastructure, with this a very confrontational and prickly issue arises that is about the effective ness of ICT based learning environment generated in the classroom processes.

Effectiveness of Information and Communication Technology (ICT) based environment need to be evaluated. Unfortunately, there is no ‘magic bullet’, which will tell you simply and easily that a certain application of ICT has had an effect on student achievement. The essentiality arises to indicate some relationships or significance between technology usage and variation or disparity in classroom processes, learning style of the learners, teachers’ empowerment, and educational reforms.

Further the need also arises to indicate that usage of technology in education should be to endorse and stimulate innovations, equality, produce life long learners, technocrats, global scientists and not only as an end in itself. Moreover, and an argumentative and contentious issue arises about the return of ICT investment in terms of students’ achievement as stakeholders are very much concerned and anxious about the same. The vivacious effectiveness of ICT usage must be demonstrated by the academicians, politicians, economists and policy planners, if the
resources are to be invested on ICT. So realizing the tremendous importance of ICT in classroom processes, the investigator felt tempted to study the effectiveness of ICT mediated instructions in science at Secondary stage.

1.18 STATEMENT OF THE PROBLEM

The present study is stated as follows:

EFFECT OF INFORMATION AND COMMUNICATION TECHNOLOGY MEDIATED INSTRUCTION ON ACHIEVEMENT IN SCIENCE SUBJECT AT SECONDARY STAGE

1.19 DELIMITATION OF THE PROBLEM

The study is delimited with respect to level and content context. It is conducted on secondary school level and the Information and Communication Technology based lesson plans and non ICT based lesson plans were developed for four units from the N.C.E.R.T. science subject syllabus of 9th class chapter 2\textsuperscript{nd} (Is Matter around Us Pure); 5\textsuperscript{th} (The Fundamental Unit of Life); 12\textsuperscript{th} (Sound) and 14\textsuperscript{th} (Natural Resources) for the ninth standard students.

1.20 OBJECTIVES

The present study is designed to achieve the following objectives:

1. To identify the ICT resources to be used by the science teacher.
2. To develop instructional plans integrated with Information and communication technologies (ICTs).
3. To study the effectiveness of treatment on the achievement of the students in science in relation to physical facilities provided in the school.
4. To study the effectiveness of treatment on the achievement of the students in science in relation to intelligence.
5. To study the effectiveness of treatment on the interest of the students in science in relation to Physical facilities provided in the schools and intelligence.
6. To study the attitude towards instructional media in relation to Physical facilities and intelligence.
1.21 HYPOTHESES

The present study is intended to test the following hypotheses to attain the objectives:

1. There is no significant difference in the achievement of the students with ICT and without ICT mediated classroom instructional strategies.

2. There is no significant difference in the achievement of the students with high intelligence and low intelligence in the subject.

3. There is no significant difference on the achievement of the students belonging to rich physical facilities schools and students belonging to the schools of poor physical facilities.

4. With ICT and without ICT mediated classroom instructions, achievement in science is equal in case of high intelligent and low intelligent groups.

5. With ICT and without ICT mediated classroom instructions, achievement in science is comparable at the two levels of physical facilities.

6. There is no significant difference in the achievement of high and low intelligent students at both the levels of physical facilities.

7. With ICT and without ICT mediated classroom instructions achievement gain scores are equal for high intelligent and low intelligent students at both levels of physical facilities.

8. There is no significant difference in the interest in science with ICT and without ICT mediated classroom instructional strategies.

9. There is no significant difference in the interest in science of the students belonging to schools with rich physical facilities and poor Physical facilities.

10. Difference in interest in science with ICT and without ICT mediated instruction is not qualified at the two levels of physical facilities.

11. There is no significant difference in the attitude towards instructional media of the students with ICT and without ICT mediated classroom instructional strategies.

12. There is no significant difference in the attitude towards instructional media of the students belonging to schools with rich physical facilities and poor physical facilities.
13. Difference in the attitude towards instructional media with ICT and without ICT mediated classroom instructions is not qualified at both the levels of physical facilities.