CHAPTER 1

INTRODUCTION

1.1 Background of the Study
1.2 Justification of the Study
1.3 Statement of the Problem
1.4 Purpose of the Study
1.5 Research Questions
1.6 Hypotheses of the Study
1.7 Definition of the Terms
1.8 Significance of the Study
1.9 Assumptions
1.10 Delimitations
Chapter 1

INTRODUCTION

“Nothing is constant in the world but change…”

Heraclitus (540 - 480 B.C.)

Undoubtedly, the advent of science and technology in general and information and communication technologies (ICT) in particular has forever changed our daily lives. Great achievements in science and technology and the use of scientific inventions and discoveries have been promoting well-being of the mankind through their application in the fields of industry, communication, transport, education, engineering, agriculture, medicine, etc. This has made science indispensable now. Science has, in fact, radically transformed the material environment of the modern world. It is liberating and enriching the mind and enlarging the human spirit. Nothing comparable to the scientific revolution in its impact on man’s development and outlook has happened since the beginning of the 20th century. There is no aspect of human life today which has not been influenced by science in one way or the other. Science has shrunk the world and totally changed the human outlook. Science is considered not only as a systematized body of knowledge but also as a way of life; a way of examining, thinking, acting, reflecting and evaluating life. If science has to be accepted as a way of life, then there is need for its complete spread in civil society. Basic knowledge and understandings of phenomenon in the physical and natural universe, skills of adjustment into the environment around us, scientific temper, appreciation of the values of science for human society and the need for peaceful and constructive uses of science in everyday life and for purposes of nation-building should become integral to the personality development of individuals. These accomplished individuals should function as members of society and citizens of the nation. A love and espousal of facts along with eschewal of prejudices, openness to new ideas and fresh thinking, balance and circumspection in arriving at judgments on controversial issues, readiness for accepting change should be constituents of an accomplished personality. Development of such qualities is a product of the rigours and discipline of science education. A meaningfully organized science education in
schools will facilitate the accomplishment of these qualities in its products, the outgoing students. This process will act as catalysis in the process of modernization in society.

Science, as a subject, has two very important virtues distinctive to it. The study of science involves training in ‘scientific method’ and develops ‘scientific altitude’ in learners. Along with this, science cultivates disciplinary qualities of mind such as systematic observation, persistence, patience, concentration of mind, logical thinking, objective and unbiased judgments, respect for truth, etc., which are essential for further exploration and scientific advancements. These qualities can be cultivated only through science subjects, which can qualify the learners to live as truly efficient citizens in a science-guided society. A well-planned science education programme can be a fruitful effort in developing the desired attitudes and shaping the scientific outlook. Recognizing the importance of science and science education, Nehru (1946) opined that ‘it is science education alone that can solve the problems like hunger and poverty, insanitation and illiteracy, superstitions, vast resource wastage of a rich country like India inhabited by starving people. Even more than the present, the future belongs to science’. The societies of the twenty-first century will, quite clearly continue to be shaped by science education; also, science education is indispensable in helping the societies from where they are now to where they aspire to be in the next century. Therefore, the proper and responsible use of science education is an urgent need of all societies especially in a developing country like India, in order to achieve the twin goals of development and improved quality of life.

The rapid advancement of science and technology and increasing need for scientific application have made it all the more important to provide for science education in schools. Even the Secondary Education Commission (1952-53), had recommended that every Secondary School pupil should study General Science as a compulsory subject, so that he/she gains a basic quantum of scientific knowledge as a part of his/her general education. In addition, provision should be made for elective subjects in science for those students who want to pursue higher study. Further, the 42nd amendment to the Indian Constitution adopted in 1976 included several fundamental duties of a citizen. One of the fundamental duties of a citizen is to develop ‘scientific temper’, and the schools are expected to develop scientific temper
among the students. This also justifies the inclusion and need of science as a subject in school education. In view of the manifold values of science, especially the utilitarian value, which are indispensable for the efficient discharge of responsibilities of a good citizen in an age of science, it has been elevated to the status of a compulsory subject at all stages of schooling. With the introduction of compulsory and free education for all, science has been assigned an important place in the curriculum and has been made one of the compulsory subjects till the secondary stage (class X) to make all students realize the need of science for society. At secondary stage, science is one of the core subjects. As a whole, science education in secondary schools has been fashioned to perform three-dimensional functions, viz. (1) as an integral part of general education; (2) as a preparatory course to college science; and (3) as preparation for vocation.

Since living in the present world invariably warrants, to variable degrees, knowledge of simple scientific facts and laws, science has become ‘everyday Science’ for everybody. Teaching of everyday science for everybody has become an integral part of general education. The science teacher should teach science in such a way that the pupils realize varied social functions of science, think, act, and contribute to the welfare of the future world. They should appreciate science as a part of modern living and that science should always be used only for the benefits of the society and not for selfish needs. In this context, future education - science education in particular - will undergo changes that one needs to envision. Science education that is offered to the students of the twenty first century should be properly designed and executed to visualize and achieve the aims and objectives of teaching science extended to the future context. The aim of the whole course extending from the elementary level to the post-graduate level should be to enable the student to acquire scientific knowledge, and in addition, come to possess some understanding of the methodology of science and further, in the very process of acquiring this understanding, the student should be enabled to develop scientific attitude. The terminal goal of the entire science education programme should be to enable the student to emerge not only as a science expert but also a young scientist imbued with scientific spirit and mentality necessary to solve the problems of the surrounding environment (Srinivasan, 1987).

In addition to this, other ultimate aims of teaching science that are more emphasized
in the future context would be: the new science education programmes should enable the pupils to understand the whole world better factually - especially the world as it affects them concretely and to help pupils investigate ways of increasing the range and depth of understanding natural processes and to relate this understanding to the many puzzling complexities of industrial society. Keeping these aims in view, science education should offer varied direct and purposeful learning experiences through which students can identify the problems and they also find solutions to them through scientific method (Vaidya, 1996). Incidentally, accidentally and intentionally, the contribution of this type of constructive science education strengthens the national economy, creates new resources, accelerates vast employment and attempts to build global outlook on problems which affect human society. Perhaps this type of futuristic science education eventually changes pupil’s behaviour and his/her idea of his/her role in the world, so that tomorrow’s citizens grow with inquiring minds and creative spirits ready to face the challenges of the 21st century.

In order to prepare future citizens for the 21st century, science education in India has undergone through a number of changes but still has been an enterprise of unresolved dichotomies and contradictions for the last many decades. For almost three decades now, science is a compulsory subject up to Class X throughout the country, yet this universal science education continues to be largely irrelevant to most students and its quality unacceptably poor. The over-all conceptualization of science curriculum at the national level has matured steadily and kept pace with evolving contemporary trends in science education the world over; yet this has hardly translated into any significant improvement in the actual teaching of science. There have been notable innovative efforts by several NGOs and other institutions, sometimes in collaboration with central and state agencies, yet these efforts have not qualitatively improved the mainstream science education. For an overwhelming majority of students, science is just another demanding and difficult subject to be learnt by rote, with no meaningful learning outcomes whatsoever, yet a small minority of students do come out of the system with outstanding competence in science comparable to international standards. Looking at the complex scenario of science education in India, three issues stand out unmistakably. First, science education is still far from achieving the goal of equity enshrined in our constitution. Second, science
education in India, even at its best, develops competence but does not encourage inventiveness and creativity. Third, the overpowering examination system is basic to most, if not all, the fundamental problems of science education in India (NCERT, 2006).

The reasons for such a situation as mentioned above are obvious. Science teaching in Indian classroom contexts is in a very bad shape. Students are successfully passing their examinations, without absorbing knowledge about the nature of scientific enterprise. Teachers fail to build quality into their science teaching. It is mainly due to the fact that the methods of teaching employed by the teacher are less effective which emphasize more on ‘product’ aspect of science rather than ‘process’ aspect (Vaidya, 1996). The present-day state of affairs in science education and science teaching in India are not up to the mark. Science teaching has been and is still oral in character. Demonstration lessons are occasionally interspersed. There is very little of practical work up to the tenth class. At the higher stages, a prescribed list of experiments is mechanically followed by the teacher in the laboratory, which is mostly in the nature of verifying knowledge, or working according to set the rules which are made explicit before introducing the real experiment to students. The element of investigation, training in the use and practice of the scientific method and even mastery of the research operations (the discovery approach to learning) are conspicuous by their absence, even at those places where laboratory facilities and equipments are generous. The aims and objectives of science education at various levels, when spelt out in detail, look grand on paper and most of them vapourize during execution. Science teaching is based strictly on the prescribed textbooks. Both students and teachers follow them strictly. Methods employed for science teaching are dull; teacher-centered and lack objectivity (Vaidya, 1996). It is for these reasons that science teaching is not considered to be related to the immediate environment at all. Consequently, training in scientific method, problem solving, creative thinking, and the development of scientific skills, interests, attitudes and appreciation remain in an utter state of neglect.

Another commonly cited defect of science teaching is that it is almost totally information-based. This makes science education at the lower levels very drab and a matter-of-fact business which often bores students. At the higher levels it runs
through the risk of becoming out of date before the student reaches maturity and takes up any scientific work on his own. The science classroom appears to be a place where children make little use of their talents and tools because the methods of teaching in vogue are not only mechanical in nature but also devoid of constructive imagination. Even though, science teaching, at all levels has changed radically, in both content and form in the wake of the recent scientific revolution, science teachers from their unexamined day-to-day classroom teaching have formed firm opinions about their wards which is too difficult to change or eradicate. In spite of many major developments in the pedagogy of science which include multi-media approach, mass communication instruction, individualized instruction, group-learning, team teaching many versions of scientific method such as inquiry approach, problem solving method, brain storming method, heuristic method, inductive method, etc, teachers in India, are employing fixed ways of teaching science in classroom. Even though a number of methods are evolved over a period of time, only some of them were rarely practised at schools and very few of them have been employed by teachers for science teaching on a large scale. This is true especially in the Indian context where schools and classrooms lack infrastructure and physical resources required for modern, technical and scientific approaches of science teaching, overloaded syllabus with less span of academic schedule and lack of initiation, motivation, exposure and innovative attitude among science teachers. The commonly used methods by teachers for science teaching are lecture method, discussion method, lecturer-cum-demonstration method, question-answer method and assignment method. Methods such as project method, laboratory method, and heuristic methods are used occasionally in schools with required facilities. These methods employed by the teachers are associated with teaching aids such as models, charts, specimens, objects and audio-visual aids. Other methods and approaches such as programmed instruction, heuristic approach, model approach, etc. are very rarely used and, by and large, restricted to experimental tryout or used for demonstration and research purposes.

Moreover, the concepts of Physical Science course are mostly abstract, and this makes the information hard to grasp and the course quite boring and difficult for the students. Thus, students can have problems in assigning meaning to information, understanding the content as a whole, locating new information in their schema and
transforming this information to knowledge. For any qualitative change from the present situation, the Indian Educational System in general and science education in particular must undergo a paradigm shift. In this regard, we may remember what Charles Darwin said, “It’s not the strongest of the species who survive, nor the most intelligent, but the ones most responsive to change.” This calls for new attempts and needs in terms of the teaching-learning processes. Among these new attempts is the use of computers in instructional endeavours as they are considered as effective communication and individualized learning tools. Computers can be used on their own or along with other instructional tools to ameliorate learning practices (Akgun, 2000). Parallel to the development of these devices, which represents the most important components of the information and communication technologies, science education in general and Physical Science instruction in particular do make use of such tools to improve learning practices. In order to remove the barriers stemming from the abundance of abstract concepts in Physical Science and sustain higher levels of learning experiences, computer assisted instruction (CAI) can be considered as a fruitful endeavour to integrate science and technology and improve the quality of learning experiences (Yenice, 2003). As indicated in several resources (Cotton, 1991; Şentürk 2005; Usun, 2000), CAI allows learners to progress at their own pace, control their learning, participate in the learning endeavours more willingly, learn more effectively, get a richer variety of instructional materials, keep track of the learning experiences, get direct answers for their unique questions, get instant feedback regarding their strengths and weaknesses, conduct experiments which are hard to realize in real-life, and learn at a shorter time in a systematic way. Computers are usually more enjoyable and always more patient than classroom teachers. They never forget to give feedback, never get tired or angry, never provide face-threatening feedbacks, and never behave according to students’ ethnic or cultural backgrounds. They provide the feedback fast, offer a large variety of instructional tools and examples, think faster than human beings, approach students more objectively, address different senses, and realize drudgery work more effectively.

Most of the history of computer technology in education can be told in two periods: before and after the introduction of microcomputers in the late 1970s (Niemiec & Walberg, 1985; Roblyer, 1992). In 1994, yet another technological
development, the World Wide Web, transformed educational technology. This development marked the beginning of the third and current era of computers in education.

Prev-microcomputer Era: This era began in the early 1950s. Although this era’s computer resources were very different from those of today, both computer companies and educators learned much at this time about the role of technology was destined to play in education. IBM was a pioneer in this field, producing the first instructional mainframe with multimedia learning stations, the IBM 1500. By the time IBM discontinued it in 1975, some 25 universities were using this system to develop CAI materials. The most prominent of these was led by Stanford University professor and “Grandfather of CAI” Patrick Suppes, who developed the Coursewriter language to create reading and mathematics drill-and-practice lessons. Other similar company- and university-led instructional initiatives ensued; Suppes founded the Computer Curriculum Corporation (CCC); the Digital Equipment Corporation created the first instructional minicomputer; and the Control Data Corporation (CDC) created the Programme Logic for Automatic Teaching Operations (PLATO) system and the Tutor CAI authoring language. For about 15 years, these mainframe and microcomputer CAI systems dominated the field. Universities also developed instructional applications for use on these systems. Among these were Brigham Young University’s Time-shared Interactive Computer-Controlled Information Television (TICCIT) system and computer managed instruction (CMI) systems based on mastery learning models, such as the American Institutes for Research’s Program for Learning in Accordance with Needs (PLAN) and Pittsburgh’s individually prescribed instruction (IPI). However, these systems were both expensive to buy and complex to operate and maintain. By the late 1970s, it was apparent that teachers disliked the control of CAI/CMI applications and began to reject the idea that computers would revolutionize instruction (Roblyer, 2006).

Microcomputer Era: The entire picture changed in the late 1970s with the invention of small, stand-alone desktop microcomputers, which wrested control of educational computers from companies, universities, and school districts and placed them in the hands of teachers and schools. Several different initiatives emerged to shape this new teacher-centered control and a software publishing movement that catered to
educators quickly sprang up. With National Science Foundation funding, the Minnesota Educational Computing Consortium (MECC) became the single largest microcomputer software provider, and a multitude of other companies soon followed. To offer advice on how to select quality products, organizations emerged to review software (e.g., Northwest Regional Education Laboratory’s MicroSIFT Project, the Educational Products Information Exchange or EPIE), and professional organizations, journals, magazines all began to publish software reviews. As teachers clamored for more input into courseware design, companies created authoring languages (e.g., PILOT, superPILOT) and menu-based authoring systems (e.g., GENIS, PASS), but teacher authoring soon proved too time consuming, and interest faded. As schools search for a way to make CAI more cost effective, school districts began to purchase networked integrated learning systems (ILSs) with pre-developed curriculum to help teachers address required standards. Control of computer resources moved once again to central servers controlled by school district offices. Also, at this time, products and research based on the Logo programming language became the focus of the field as a result of Seymour Papert’s work (1987). The Logo view of technology – that the computers should be used as an aid to teach problem-solving – began to replace traditional instructional computer uses (e.g., drills, tutorials) as the best use of technology. Yet despite its popularity and research showing it could be useful in some contexts, researchers could capture no impact from Logo use on mathematics or other curriculum skills, and interest in Logo, too, waned by the beginning of the 1990s (Roblyer, 2006).

Internet Era: Just as teachers seemed to be losing interest once again in technology’s potential for instruction, the first browser software (Mosaic) transformed a formerly text-based Internet into a combination of text and graphics. By the last part of the 1990s, teachers and students joined the throng of users on the “Information Superhighway.” By the beginning of 2000s, email, online (i.e., web-based) multimedia, and videoconferencing became standard tools of Internet users, and portable devices made Internet access ubiquitous. The ease of access to online resources and communication drove a dramatic increase in distance learning offerings, first in higher education, then in K-12 schools. As interest in technology in education began to expand once more, the International Society for Technology in
Education (ISTE) developed National Educational Technology Standards (NETS) for administrators, teachers, and students (Roblyer, 2006).

1.1 Background of the Study

A few earlier researchers had compared the effectiveness of CAI with traditional instruction in different curricular areas. Their findings, though not conclusive, indicate that CAI activities are most effective in the areas of science and foreign languages, followed, in descending order of effectiveness, by activities in mathematics, reading, language arts, and English as a Second Language (Capper & Copple, 1985; Kulik, Kulik, & Bangert-Drowns, 1985, Roblyer, Castine, & King, 1988; Rodriguez & Rodriguez, 1986). Similarly, a number of research studies have been conducted, in the last two decades, to compare the effects of computer assisted instruction (CAI) and traditional instruction (TI) on student achievement in a variety of disciplines and at different levels. However, these studies have produced mixed results. Some studies (Fante, 1995; Rutherford & Lloyd, 2001; Tsai et al., 2004) suggest that CAI is more effective than TI with respect to student achievement, whereas other studies (Adams & Kandt, 1991) claim that CAI and TI are equally effective. Furthermore, a few studies (May, 1995; Watkins, 1996) suggest that CAI is less effective than TI with respect to student achievement.

In developed countries, where computers became available in schools several decades earlier than in India, a large number of meta-analyses have been undertaken to study the efficacy of CAI in terms of different outcomes. To consolidate findings from three decades of CAI studies, some researchers (Bayraktar, 2001; Blok, Oostdam & Otter, 2002; Christmann & Badgett, 2003; Christmann, Badgett & Lucking, 1997; Fletcher-Flinn & Gravatt, 1995; Hsu, 2003; Khalili & Shashaani, 1994; Kulik & Kulik, 1991; Lee, 1999; Liao, 1992; Niemiec & Walberg, 1985; Soe, Koki & Chang, 2000; Wise, 1988; Yaakub & Finch, 2001; Yuen-Kuang, 1998) conducted meta-analyses. Kulik and his associates have reported several studies focused on the effectiveness of computer based education in elementary and secondary schools, colleges and adult education (Kulik & Kulik, 1986; Kulik & Kulik, 1991; Kulik, Kulik & Schwalb, 1986; Kulik, Kulik & Bangert-Drowns, 1985; Kulik, Kulik & Cohen, 1980). In these studies, positive outcomes were found on
students in favour of computer assisted instruction. Although several meta-analyses (Fletcher-Flinn & Gravatt, 1995; Kulik & Kulik, 1991; Liao, 1992; Niemiec & Walberg, 1985) focused on the effectiveness of computers in general, only three studies (Bayraktar, 2001; Christmann & Badgett, 2003; Wise, 1988) focused exclusively on science education. Wise included 26 studies reflecting the situation of computer-based instruction prior to 1988. However, in that study, nearly half of the effect size measures came from studies investigating the effects of computer applications other than CAI. In a more recent meta-analysis, Christmann & Badgett (2003) synthesized the results of 11 studies comprising of CAI in the areas of physics, chemistry, biology, and general science, and concluded that CAI is most effective in general science, followed by physics, chemistry, and biology. Bayraktar (2001) carried out a meta-analysis to investigate the effectiveness of CAI on student achievement in secondary and college science education as compared to traditional instruction. The results indicated a small positive effect for CAI use in science and revealed that computers are more effective when used in simulation or tutorial modes; CAI is more effective when computers were used individually, and when it is used as a supplement to traditional instruction rather than as a substitute; and experimenter- or teacher-developed CAI programs were more effective than commercial software programs.

A summary of the analysis of 59 research reports by Cotton (1991) that documents some relationships between computer-based learning and student outcomes provides an excellent overview of studies in the area of CAI. Cotton summarized the findings of 28 research studies, 22 reviews, and 9 meta-analyses of research studies. The outcome areas examined included: academic achievement in general (30), in mathematics (13), in language arts (8), in reading (3), in science (2), in problem-solving skills (2), and in health and social studies (1 each). The general findings that emerged from this analysis are: the use of CAI as a supplement to conventional instruction produces higher achievement than the use of conventional instruction alone; research is inconclusive regarding the comparative effectiveness of conventional instruction alone and CAI alone; Computer-based education (CAI and other computer applications) produce higher achievement than conventional instruction alone; students learn material faster with CAI than with conventional
instruction alone; and students retain what they have learned better with CAI than with conventional instruction alone. Similar generalizations were drawn by Fouts (2000) in his study, which included the use of computer as tutor and surrogate teacher. He points out that this line of research has produced hundreds of studies over the past several decades. While there are methodological problems with much of the research, there is some degree of general concurrence as follows: when combined with traditional instruction, the use of computers can increase student learning in the traditional curriculum and basic skills area; the integration of computers with traditional instruction produces higher academic achievement in a number of subject areas than does traditional instruction alone; and students learn more quickly and with greater retention when learning with the aid of computers.

Much of the research that examines the effects of CAI and other microcomputer applications on student learning outcomes investigates effects upon student attitudes. This line of inquiry has brought most researchers to the conclusion that the use of CAI leads to more positive student attitudes than the use of conventional instruction. This general finding has emerged from studies of the effects of CAI on student attitudes toward computers and the use of computers in education (Batey, 1986; Ehman & Glen, 1987; Kulik, 1985; Roblyer, 1988); course content/subject matter (Batey, 1986; Braun, 1990; Dalton & Hannafin, 1988; Ehman & Glen, 1987; Hounshell & Hill, 1989; Roblyer, et al., 1988; Rodriguez & Rodriguez 1986); and quality of instruction (Kulik & Kulik, 1987; Rupe, 1986). Many studies have developed and defined constructs around students’ attitudes toward science when computers were introduced to the science classroom. For instance, the constructs are achievement in science (Ma, 1997; Ma & Xu, 2004), confidence oneself toward science (Hannafin, 2004; Smeets, 2005), teaching styles (Barton, 2000; Ruthven, Hennessy, & Deaney, 2005; Smeets, 2005), motivation (Edelson, 2001; Jeon, 1994), engagement in science activities (Bulter, MacGregor, 2003; Bazler, Spokane, Ballard & Fugate, 1993; Williams et al., 2003). Achievement in a subject is the most important factor in one’s attitudes toward the subject (Ma, 1997; Ma & Xu, 2004). Following the constructivist perspectives, some, programs focus on conceptual understanding, so they provide specific domain knowledge (Hsu & Thomas, 2002; Linn, 1992; White & Fredrikson, 1998), and visualization of abstract
concepts or principles (Clark & Jorde, 2004; Noh, Cha, Kim, & Choi, 1998; Winn, 2003). Visualization and animations provided by CAI programs and the Internet resources led to the enhancement of students’ conceptual understanding, and they were more effective than text or diagrams in promoting knowledge integration and enhancing students’ attitudes and interests (Bell & Linn, 2000; Davis & Linn, 2000; Clark & Jorde, 2004; Sadler, Gould, Brecher & Hoffman, 2000). Clark and Jorde (2004) designed the thermodynamics class with visual discrepant events to reach the conceptual reorganization of students. During the post-interview all students of the experimental group demonstrated the positive impact of the visualized tactile model.

The flexibility of CAI programs also brought self confidence in science and it plays an important role in changing attitudes (Hannafin, 2004; Smeets, 2005). CAI programs easily provide additional materials for the learners, which may be accessed by both required lower and higher achievement students. The students can receive feedback as to performance and appropriate paths to follow as well as choosing a particular degree of difficulty and choosing the amount of problem practice required. In the learner controlled learning environment (Hannafin, 2004), learners have more responsibility for their learning than in instructor controlled environments. In addition, positive self concept was led toward science; therefore, students’ learning attitudes change positively. When an instructor changed his/her teaching styles from lecture-based to collaborative grouping using delivered teaching resources and discussion mediated with ICT, students responded positively to the classes (Barton, 2000; Ruthven et al., 2005; Smeets, 2005). Teachers reconstructed class activities and focused on what students would do in the classes utilizing ICT rather than what the teachers would teach. Teachers as facilitators provided diverse learning activities and resources through the use of ICT (Barton, 2000), and encouraged collaborative activities with others and computer programs (Ruthven et al., 2005). Smeets (2005) investigated the relation between teaching style and student attitude changes from the teachers’ perspective. He conducted a survey with teachers (N=328) who used CAI programs in their classes and the reported results demonstrated that 98% (N=328) of teachers answered that CAI programs stimulated their students to work autonomously and to encourage engagement in class. The strength of learning activities with technology was seen as helping to stimulate students’ interest, engagement in and
positive attitudes toward the lessons. Similarly, Cotton (1991) concluded that the use of CAI leads to more positive attitudes toward computers, course content, and quality of instruction. Fouts (2000) also pointed out that students like learning with computers, and their attitudes toward learning and school are positively affected by computer use.

In introducing computer-assisted instruction tools as a method of teaching in schools, it becomes important to know how willing the students are to accept instruction using technology and investigate what attitudes students have regarding computer-assisted learning. Spain and Allen (1990) reported that offering supplementary computerized instruction in a freshman chemistry course received strong support from students. Skinner (1988) determined the attitudes of college students toward working with CAI in a personalized instruction course. Student responses indicated a positive rating of the instructional effectiveness and appropriateness of CAI. Meta-analysis by Wise and Okey (1983) indicated that students who used computers obtained significantly higher course averages, improved performance, and positive attitudes toward the use of computers in their coursework. These findings point to the obvious fact that the outcome of CAI depends critically on the quality of the courseware used to deliver the instruction. According to Ruffin (2000), students’ positive attitude toward CAI plays a key role in the success of CAI implementation. He investigated the relationship between demographic variables and student attitudes toward computer-aided instruction and concluded that attitude towards computers, average daily exposure to computers and computer-literacy courses were the significant variables that influence the attitude towards CAI. Another study which was conducted by Vale (2001) also supported Ruffin’s results. The results of Vale’s study indicated that the length of time using computer in mathematics and the nature of the learning environment were two factors that impact the students’ attitude towards computer-based mathematics. Most researchers have concentrated on “attitude toward computers” as a demographic variable in CAI related studies. For example, Kulik and Kulik conducted a meta-analysis study in 1991 to investigate the relationship between computer-based instruction (CBI) and students’ achievement and attitudes. Results showed that CBI usually produced positive effects on learners of all ages, from children to adults (Kulik & Kulik, 1991).
The authors also added that CBI produced small but positive changes in student attitudes toward teaching and computers.

The effective exploitation of CAI and successful achievement of the intended goals rely heavily on the students’ perceptions of learning environment created by using CAI. Bliss (1991) found that a majority of students learned better with a computer in a science and technology course and it was more interesting for them to learn using a computer. Similar results were reported by a number of researchers (Hasselbring, 1986; Lazarowitz & Huppert, 1993; Ross & Casey, 1994). According to a number of researchers and science educators, interactivity is the primary reason that computers are the dominant tools in education today; the development of CD-ROM technology for the computer has enabled students to be actively involved in the learning process (Lazarowitz & Huppert, 1993; Matray, 1996); computer technology would help teachers provide students with effective opportunities to learn both science content and processes (Weller, 1996); and computer programs provide teachers with additional tools to stimulate students and bring about enthusiasm for the subject (Sipress, 1995). Thus, CAI seems to help in achieving the goals of providing a positive and stimulating learning environment. The learning environment has a big influence on student outcomes and plays an important role in improving the efficiency of learning. Studies consistently have shown evidence of relations between student perceptions of their classroom learning environment and their cognitive and affective outcomes (Chionh & Fraser, 1998; Fraser, 1994; Henderson, Fisher, & Fraser, 1995; Hunus & Fraser, 1997; Margianti, Fraser & Aldridge, 2001; Myint & Goh, 2001; Roth, 1998). Students learn better when they perceive their classroom environment positively (Chionh & Fraser, 1998). There is a positive relation between perceptions of learning environment and attitudinal outcomes and thus, classroom learning environment is considered as the strongest predictor of attitude toward science in all grades (Hunus & Fraser, 1997; Myint & Goh, 2001; Rawnsley & Fisher, 1998; Talton & Simpson, 1987).

There are few studies of the use of CAI in science teaching at the secondary school level in India. According to Buch’s survey (1991) published by NCERT (National Council of Educational Research and Training), computers and computer-based learning systems are gaining ground all over our country, and researchers must
attempt to assess the facilitative effect of these specialized learning strategies in terms of learning outcomes, learning time and attitudes. However, in a review of India-based research between the years 1988-92 (NCERT, 1997, p. 426), it is interesting to note that CAI could lure only three researchers. Research studies on CAI in India conducted by Avinashlingam in 1993 and Shailaja in 1986 proved CAI to be more effective than traditional methods of science teaching in terms of achievement and improvement in science knowledge. In 1991, Jeyamani (NCERT, 1997, p. 426), who developed a computer assisted instructional package in physics, also found that the experimental group performed significantly better on the post-test, but no significant differences were found in terms of sex and medium of instruction. Many more studies have been undertaken in India on CAI since 1997; some of which are reported in chapter 2, but the findings of the remaining ones are not available as yet.

1.2 Justification of the Study

Three recent survey reports present a dismal picture of the quality of science education in India. According to Annual Status of Education Report (ASER, 2011), an exhaustive survey spread over the length and breadth of rural India involving more than 14000 villages, not only are India’s learning levels very poor on an international absolute scale, the levels in government schools have steadily declined with few exceptions. Quality Education Study (QES) report (2012), conducted by the Wipro’s education initiative, corroborates this depressing state of affairs in the quality of science education in India even further. According to QES report, there is a 5-10% drop in learning levels in the last few years in Maths and Sciences. This is particularly disturbing as the task of improving the learning levels becomes more daunting as we have to first find ways to arrest this decline in the learning levels. Further, the QES study, which assessed 23,000 students, 790 teachers and 54 principals of 89 English-medium private primary and secondary schools in the metropolitan cities of India, concludes that even the top schools of our country exhibit rote learning and perform much below the international average. Another international survey, Programme for International Students Assessment (PISA, 2011), conducted by the Australian Council for Educational Research, shows that among 74 countries-including the US, UK, Canada, China, South Korea etc., Indian students are ranked at 73rd position with
only Kyrgyzstan performing worse. Another problem in India is the growing unemployment of science literates. The India Science Report (2005) found that of the total educated population, as we move towards higher education, the share of unemployed science literates increases significantly. For instance, of the postgraduates who are unemployed, about 63% have studied science. This is also true in the case of science diploma holders; 53% unemployed belong to the science stream. While these surveys may not be encouraging, these are essential as only then do we understand as to what is ailing our education system and devise ways and means to challenge and encourage students in the various branches of science. This is particularly important as India aspires to become a knowledge-based economy and in that context it is vital to see as to how our future scientific labour force is being groomed and motivated (Malik, 2012). Therefore, systematic approaches (such as experiments and pilot studies) should be employed in order to promote integration of the computer into instruction and the curriculum in general.

The most recent science curriculum standards in India emphasize the use of computers in assisting science teaching and learning in the classrooms. For instance, the National Focus Group of the National Council of Educational Research and Training (2006, p. 27) points out that, “Although the vast potential of ICT in the field of science education has been well recognized, it still remains largely untapped. The efforts have been piecemeal and sporadic.” They further add that though ICT shows renewed promise today, “there is the need to make available quality software in different disciplines of science” and “appropriate multimedia software—both in English and other languages-suited for various age groups in schools is still a rare commodity.” According to National Policy on ICT in school education (2012), there is an urgent need to develop and deploy a large variety of applications, software tools, media and interactive devices in order to promote creative, aesthetic, analytical, and problem solving abilities and sensitivities in students and teachers. It recommends that a programme of ICT literacy will be implemented across all secondary schools in the States, both government and private within the XII plan period, and a model Curriculum for ICT in Education (CICT) will be developed at National Level and States will be encouraged to adopt/adapt it.
Even with widespread optimism about the usage of CAI in the science classroom, confounding research findings on the comparative effectiveness of CAI versus traditional instruction are present in the science education literature. Some research found that CAI was effective in improving students’ science achievement or their attitudes toward science (Chang, 2001a, 2001b, 2002; Ferguson & Chapman, 1993; Levine, 1994; McCoy, 1991; Yalcinalp, Geban, & Ozkan, 1995). On the other hand, other researchers have found that the CAI approach has no significant effects on cognitive achievement or science learning (Morrell, 1992; Olugbemiro, 1991; Wainwright, 1989). The aforementioned mixing research results perhaps stemmed from some unknown factors that might have revolved around the CAI treatment and students’ perceptions of learning environment in the science classes. After reviewing meta-analyses and other studies of media’s influence on learning, Clark (1983, 1985) concluded that there are no learning benefits to be gained from employing any specific medium to deliver instruction. He went on to argue that most media or CAI comparison research, which compared CAI with conventional instruction or other media, has merely suffered from inherently flawed methodologies. He also made the claim that media are only the vehicles that deliver instruction but that they do not influence student achievement or learning (Clark 1994). In view of that, it might be more important and appropriate to investigate the relative effectiveness of different computer assisted instructional methods and traditional teaching on students’ science learning outcomes. Furthermore, while a number of previous studies and meta-analyses have primarily focused on the comparative efficacy of computer assisted instruction versus traditional instruction in the area of science education, there are relatively fewer inquiries exploring how various teaching formats or approaches of CAI, namely, teacher-centered and student-centered CAI influence students’ science learning outcomes in the secondary classroom. Unfortunately, in India, there is not only a limited number of research studies that had focused primarily on the comparative efficacy of CAI versus traditional instruction but also hardly any research investigating how different teaching formats of CAI can influence students’ learning outcomes in the area of Physical Science at secondary school level. Therefore, this study was undertaken to compare the effects of traditional teaching, teacher-centered and student-centered CAI on secondary school students’ attitude and achievement in Physical Science with the aim of improving science instruction in the
secondary school classrooms of India. In this study, three groups of students were taught by traditional teaching, teacher-centered and student-centered CAI respectively in order to study the effects of these three instructional methods on their attitude and achievement in Physical Science. Furthermore, two latent variables, namely, CAI attitude and CAI Environment Attitude were also used as predictors to estimate their contribution towards students’ attitude and achievement in Physical Science.

1.3 Statement of the Problem

“A Comparative Study of the Effects of Traditional Teaching and Computer Assisted Instruction on Secondary School Students’ Attitude and Achievement in Physical Science”

1.4 Purpose of the Study

The purpose of this study is to evaluate the effectiveness of multimedia CAI software for teaching Physical Science to secondary school students and to assess the effects of CAI on their attitude and achievement in Physical Science along with their attitude towards CAI. Before the researcher can proceed further with the study, it is essential to set a goal or an objective. Effective research is undoubtedly a matter of aiming in the right direction. Keeping the above purpose in view, the proposed study was aimed at achieving the following objectives:

1. To develop three measuring instruments, namely, Physical Science Attitude Scale, Physical Science Achievement test, and Computer Assisted Instruction Attitude Scale.

2. To evaluate the effectiveness of multimedia CAI software for teaching Physical Science to secondary school students.

3. To compare the attitude towards Physical Science at pre-test and post-test stages respectively for students in the control group.

4. To compare the attitude towards Physical Science at pre-test and post-test stages respectively for students in the Teacher-centered CAI (TCCAI) group.

5. To compare the attitude towards Physical Science at pre-test and post-test stages respectively for students in the Student-centered CAI (SCCAI) group.

6. To compare the effects of traditional teaching and Computer Assisted Instruction (Teacher-centered CAI and Student-centered CAI) on attitude
towards Physical Science for students in the control group and two experimental groups (TCCAI and SCCAI) respectively.

7. To compare the achievement in Physical Science at pre-test and post-test stages respectively for students in the control group.

8. To compare the achievement in Physical Science at pre-test and post-test stages respectively for students in the Teacher-centered CAI (TCCAI) group.

9. To compare the achievement in Physical Science at pre-test and post-test stages respectively for students in the Student-centered CAI (SCCAI) group.

10. To compare the effects of traditional teaching and Computer Assisted Instruction (Teacher-centered CAI and Student-centered CAI) on achievement in Physical Science for students in the control group and two experimental groups respectively.

11. To examine the effects of traditional teaching and Computer Assisted Instruction (Teacher-centered CAI and Student-centered CAI) on achievement in Physical Science for students in the control group and two experimental groups respectively at different levels of the cognitive domain (viz., knowledge, comprehension, application, HOTS).

12. To explore the effects of traditional teaching and Computer Assisted Instruction (Teacher-centered CAI and Student-centered CAI) on achievement in Physical Science for students in the control group and two experimental groups respectively in different content areas (Physics and Chemistry) of Physical Science.

13. To study the combined and individual effect of CAI attitude subscales on attitude towards Physical Science for students in the TCCAI and SCCAI groups respectively.

14. To study the combined and individual effect of CAI attitude subscales on achievement in Physical Science for students in the TCCAI and SCCAI groups respectively.

15. To study the combined and individual effect of CAI environmental subscales on attitude towards Physical Science for students in the TCCAI and SCCAI groups respectively.

16. To study the combined and individual effect of CAI environmental subscales on achievement in Physical Science for students in the TCCAI and SCCAI groups respectively.

17. To point out the main educational implications of this study.
1.5 Research Questions

Keeping the objectives in view, the following research questions were framed:

1. Is there any significant difference between the mean pre-test and post-test Physical Science attitude scores for students in the control group?

2. Is there any significant difference between the mean pre-test and post-test Physical Science attitude scores for students in the TCCAI experimental group?

3. Is there any significant difference between the mean pre-test and post-test Physical Science attitude scores for students in the SCCAI experimental group?

4. Is there any significant main effect of instructional method on mean post-test Physical Science attitude scores for students in the control, TCCAI, and SCCAI groups respectively?

4.1 Is there any significant main effect of instructional method on mean post-test Physical Science attitude scores for students in the control, TCCAI, and SCCAI groups respectively?

4.2 Is there any significant main effect of gender on mean post-test Physical Science attitude scores for students in the control, TCCAI, and SCCAI groups respectively?

4.3 Is there any significant interaction effect of instructional method and gender on mean post-test Physical Science attitude scores for students in the control, TCCAI, and SCCAI groups respectively?

5. Is there any significant difference between the mean pre-test and post-test achievement scores for students in the control group?

6. Is there any significant difference between the mean pre-test and post-test achievement scores for students in the TCCAI group?

7. Is there any significant difference between the mean pre-test and post-test achievement scores for students in the SCCAI group?

8.1 Is there any significant main effect of instructional method on mean post-test achievement scores for students in the control, TCCAI, and SCCAI groups respectively?

8.2 Is there any significant main effect of gender on mean post-test achievement scores for students in the control, TCCAI, and SCCAI groups respectively?

8.3 Is there any significant interaction effect of instructional method and gender on mean post-test achievement scores for students in the control, TCCAI, and SCCAI groups respectively?
9. Is there any significant difference between the mean post-test scores for students in the control, TCCAI, and SCCAI groups respectively, at different levels of cognitive domain?

10. Is there any significant difference between the mean post-test scores for students in the control, TCCAI, and SCCAI groups respectively, in different content areas of Physical Science?

11. Do CAI attitude subscales significantly predict the attitude towards Physical Science for students in the TCCAI and SCCAI groups respectively?

12. Do CAI attitude subscales significantly predict the achievement in Physical Science for students in the TCCAI and SCCAI groups respectively?

13. Do CAI environment subscales significantly predict the attitude towards Physical Science for students in the TCCAI and SCCAI groups respectively?

14. Do CAI environment subscales significantly predict the achievement in Physical Science for students in the TCCAI and SCCAI groups respectively?

1.6 Hypotheses of the Study

Formulation of hypotheses is one of the most important parts of a research study since they provide direction to research. The investigator was guided by the results of previous researchers in the area of CAI, and investigator’s intuitive understanding and insight. The following research hypotheses are formulated in null form in the light of the above mentioned research questions for empirical verification:

**H₀ 1:** There is no significant difference between the mean pre-test and post-test Physical Science attitude scores for students in the control group.

**H₀ 2:** There is no significant difference between the mean pre-test and post-test Physical Science attitude scores for students in the TCCAI group.

**H₀ 3:** There is no significant difference between the mean pre-test and post-test Physical Science attitude scores for students in the SCCAI group.

**H₀ 4.1:** There is no significant main effect of instructional method on mean post-test Physical Science attitude scores for students in the control, TCCAI, and SCCAI groups respectively, after controlling for the effect of pre-test as a covariate.

**H₀ 4.2:** There is no significant main effect of gender on mean post-test Physical Science attitude scores in the control, TCCAI, and SCCAI groups respectively, after controlling for the effect of pre-test as a covariate.
H₀ 4.3: There is no significant interaction effect of instructional method and gender on mean post-test Physical Science attitude scores for students in the control, TCCAI, and SCCAI groups respectively, after controlling for the effect of pre-test as a covariate.

H₀ 5: There is no significant difference between the mean pre-test and post-test achievement scores for students in the control group.

H₀ 6: There is no significant difference between the mean pre-test and post-test achievement scores for students in the TCCAI group.

H₀ 7: There is no significant difference between the mean pre-test and post-test achievement scores for students in the SCCAI group.

H₀ 8.1: There is no significant main effect of instructional method on mean post-test achievement scores for students in the control, TCCAI, and SCCAI groups respectively, after controlling for the effect of pre-test as a covariate.

H₀ 8.2: There is no significant main effect of gender on mean post-test achievement scores for students in the control, TCCAI, and SCCAI groups respectively, after controlling for the effect of pre-test as a covariate.

H₀ 8.3: There is no significant interaction effect of treatment and gender on mean post-test achievement scores for students in the control, TCCAI, and SCCAI groups respectively, after controlling for the effect of pre-test as a covariate.

H₀ 9: There is no significant difference between the mean post-test achievement scores for students in the control, TCCAI, and SCCAI groups respectively, at different levels of cognitive domain, after controlling for the effect of pre-test as a covariate.

H₀ 10: There is no significant difference between the mean post-test achievement scores for students in the control, TCCAI, and SCCAI groups respectively, in different content areas of Physical Science, after controlling for the effect of pre-test as a covariate.

H₀ 11: CAI attitude subscales do not significantly predict the attitude towards Physical Science for students in the TCCAI and SCCAI groups respectively.

H₀ 12: CAI attitude subscales do not significantly predict the achievement in Physical Science for students in the TCCAI and SCCAI groups respectively.

H₀ 13: CAI environment subscales do not significantly predict the attitude towards Physical Science for students in the TCCAI and SCCAI groups respectively.

H₀ 14: CAI environmental subscales do not significantly predict the achievement in Physical Science for students in the TCCAI and SCCAI groups respectively.
1.7 Definition of the Terms

For the purpose of this study, several terms used need to be defined in a clear and non-ambiguous way so as to facilitate the reader’s understanding of the study. This study will utilize specific terminologies that are described in this section as follows:

1.7.1 Traditional Teaching

Traditional Teaching or instruction is meant to be a teacher-directed classroom lecture based on textbook and involving no computer use. Typically, it involves a “chalk and talk” process where the teacher answers questions about the previous lesson, introduces and lectures on a new topic and concludes the class lecture by assigning homework from the new topic. It involves classes or labs using conventional lecture/demonstration instructional methods to teach students (Liao, 1998).

Traditional instruction is teacher-centered and lecture-based. Teacher-directed and teacher-guided instructional approaches are types of traditional instruction since students often take on a passive role in the learning process (Bradley, 1997). Teacher-directed approach describes the role of the teacher as the primary lecturer disseminating information to students. As the ‘sage on the stage’, the teacher gives explicit directions and plans out exactly the course in which instruction will take place. Teacher-guided approach describes the role of the teacher as a facilitator or mentor during instruction. As the ‘guide on the side’, the teacher sets clear expectations, provides guidance and keeps the learning well-structured and productive (McKenzie, 1998).

Therefore, the investigator’s operational definition of traditional teaching is the process of transferring information, including written, oral, and visual, by a teacher in a classroom setting, using a textbook, traditional teaching methods (lecture, demonstration, lecture cum demonstration methods, etc.) and teaching aids (charts, models, etc.).
1.7.2 Computer Assisted Instruction (CAI)

Cotton (1991) presented a synthesis of definitions of CAI and represent commonly accepted (though certainly not the only) definitions of these terms:

- **Computer-based education (CBE)** and **computer-based instruction (CBI)** are the broadest terms and can refer to virtually any kind of computer use in educational settings, including drill and practice, tutorials, simulations, instructional management, supplementary exercises, programming, database development, writing using word processors, and other applications. These terms may refer either to stand-alone computer learning activities or to computer activities which reinforce material introduced and taught by teachers.

- **Computer-managed instruction (CMI)** can refer either to the use of computers by school staff to organize student data and make instructional decisions or to activities in which the computer evaluates students' test performance, guides them to appropriate instructional resources, and keeps records of their progress.

- **Computer-enriched instruction (CEI)** is defined as learning activities in which computers (1) generate data at the students' request to illustrate relationships in models of social or physical reality, (2) execute programs developed by the students, or (3) provide general enrichment in relatively unstructured exercises designed to stimulate and motivate students.

- **Computer-assisted instruction (CAI)** is a narrower term and most often refers to drill-and-practice, tutorial, or simulation activities offered either by themselves or as supplements to traditional, teacher-directed instruction.

CAI has been described in a wide variety of ways in the literature (Robyler, 2006). Robyler (2006) described CAI as the use of a computer to provide the course content in the form of drill, practice, tutorial, and simulations. Mahmood (2004) described CAI as a process by which visual information is presented in logical sequence to the learner through a computer by which the student learns through reading the text presented, or by observing the information displayed. All the
definitions of CAI presented concur that the computer plays a role of tutor and imparts instruction through different modes of presentations.

1.7.3 Types or Modes of CAI

CAI software can differ in methods and modes, as well as quality. Robyler (2006) identified five common software delivery methods: (a) drill-and-practice, (b) tutorials, (c) simulations, (d) instructional games, and (e) problem-solving programs. Although some programs may have characteristics of more than one of these types, educators need to understand the importance of determining which type of software is appropriate for each instructional setting.

![Figure 1.1: Modes of CAI](image)

1.7.3.1 Drill-and-Practice

The first method of CAI is drill-and-practice software. This type of software is typically used to help students to remember isolated facts and concepts. The purpose of drill-and-practice software is to assist the learner in memorizing facts (Kausar, Chaudhry, & Gujjar, 2008). Drill-and-practice software is designed to deliver individualized practice and serve as a supplement to regular instruction. The program presents a question to the learner, the learner responds, and the software then gives
feedback regarding whether the answer is correct or incorrect (Robyler, 2006). Most drill-and-practice software will accept two incorrect answers, and then provide the correct answer so the learner is not stuck on a particular item for a long period of time. Drill-and-practice software is one of the easiest types of educational software. The curricular applications for drill-and-practice software include any area where basic skill mastery is required. Memorization of math facts, grammar practice, and foreign language vocabulary practice are examples of appropriate use of this software. During drill-and-practice, a reward follows a correct response.

1.7.3.2 Tutorial

The second CAI method is tutorial software. Robyler (2006) defined tutorial software as a type of instructional software that offers a complete sequence of instruction on a given topic. The purpose of tutorial software is to instruct the learner (Kausar, Chaudhry, & Gujjar, 2008). This type of software may include guided practice, but it is primarily used to assume the role of the teacher (Mahmood, 2004). Tutorial software has the following five functions, (a) to assess the learner’s skill; (b) to present new information; (c) to provide practice; (d) to ask a question; and (e) depending on the learner’s response, either to remediate by re-teaching, or to progress onto the next level. Like drill-and-practice, tutorial software is designed to allow the learner to answer every question as he or she moves at his or her own pace while providing feedback in private. If a learner already knows some of the material, he or she can proceed to new, unfamiliar material. Tutorials can be used in language instruction, mathematics, and writing. Most software programs come with built-in tutorials that help show the learner how to navigate through the program.

1.7.3.3 Simulation

The third CAI method is simulation software. Robyler (2006) defined simulation software as a type of software that models a real or imaginary system to teach the principles on which the system is based. Its purpose is to provide a likeness of a real life situation (Kausar, Chaudhry, & Gujjar, 2008). Simulations have historically been used in flight training, driver education, and medical diagnosis classes. This type of software presents a situation to the learner. The learner then makes choices as the software responds to each choice by taking one of several paths. Simulations and games are also among the most frequently used computer
applications. Simulation software provides learner with an opportunity to work cooperatively, solve problems, and speculate. This type of software is time effective, cost-effective, and safer than experiencing the situation firsthand.

Simulation software can be used in social studies, science, and math. Video simulations, which are designed to provide trial and error learning, offer immersive environments moving the student from novice understanding toward expert understanding within the content domain. Teachers need to let students know what standards are being addressed and why the simulation game environment is most appropriate for learning those standards. Simulation games employ instructional practices that increase motivation such as allowances for individual differences, active participation, repeated practice, immediate feedback, realistic contexts, relevant goals, and social interaction.

1.7.3.4 Instructional Games

The fourth type of CAI mode is instructional games. Robyler (2006) defined instructional games as a computer function designed to increase motivation by adding game rules to a learning activity. Instructional games are frequently used to reinforce factual knowledge at the lower levels of the taxonomy (Kausar, Chaudhry, & Gujjar, 2008).

1.7.3.5 Problem-Solving

The fifth type of CAI is problem-solving programs. Robyler (2009) defined problem-solving programs as an instructional software function that either teaches specific steps for solving certain problems, or helps the student learn general problem-solving behaviours for a class of problems. Problem solving software is often used for cooperative group learning, although it can stimulate competition as well. The learner is presented with a problem, he or she then considers various approaches, makes a decision and acts, receives feedback, and either refines the attempt or succeeds in solving the problem (Kausar, Chaudhry, & Gujjar, 2008; Mahmood, 2004).

Computer Assisted Instruction has become an all encompassing term, denoting computer-oriented instruction at one end of the spectrum and instructional computing at the other end. The term ‘Computer Assisted Instruction’ has been defined in different ways.
According to ‘International Dictionary of Education’ (1985), the term ‘Computer Assisted Instruction’ may be defined as, “use of a computer to assist in the presentation of instructional materials to a student, to monitor learning progress, or to select additional instructional material in accordance with the needs of individualized learners.”

According to ‘Concise Encyclopedia of Special Education’ (2004), ‘Computer Assisted Instruction’ refers to educational software that can be run by students with little or no teacher assistance. In CAI, the computer presents information, asks questions, and verifies responses in much the same way a teacher does, and allows students to work at their own levels and paces.

It is a method of instruction in which the computer is used to instruct the student and where the computer contains the content which is designed to teach and guide the student (Association for Educational Communications and Technology, 1997).

It is defined as any computer based learning application that supplements a classroom environment. These applications can be delivered via CD-ROM, the World Wide Web, or other electronic resources. Typically, learners interact with the computer alone without the assistance of a teacher to answer questions. It is operationally defined as “the interaction of a learner with a computer in a direct instructional role” (Lockard, Abrams, and Many, 1997).

Therefore, the investigator’s operational definition of Computer Assisted Instruction is the use of multimedia CAI software in an educational setting (classroom or computer lab) that consists of logically sequenced interactive tutorials, drill and practice, and simulation instructional activities.

1.7.4 Secondary School Students

Secondary school which serves as a step towards preparation for higher and professional education has been described by ‘The New International Webster’s Comprehensive Dictionary of English Language’ as:

“high school or preparatory school beyond the elementary or primary and below the college level.”

According to ‘Wikipedia’,

29
“secondary school is a term used to describe an educational institution where the final stage of compulsory schooling, known as secondary education, takes place. It follows on from elementary or primary education.”

According to ‘Merriam-Webster’s collegiate dictionary’ (1993), secondary school is the stage where education that follows the typically compulsory, comprehensive primary education, is given. It is a school that is intermediate in level between elementary school and college and that usually offers general, technical, vocational, or college preparatory curricula.

In India, educational system at school level is classified as:

- Primary school education: Standards I to V
- Middle school education: Standards VI to VIII
- Secondary school education: Standards IX to X
- Senior secondary school education: Standards XI to XII

Therefore, in this study, those students who are enrolled in class X are considered as secondary school students.

1.7.5 Physical Science

According to ‘Merriam-Webster’s collegiate dictionary’ (1993), Physical Science is any of the natural sciences (as physics, chemistry, and astronomy) that deal primarily with non-living materials.

According to ‘Merriam-Webster’s collegiate dictionary’ (1993), Physics is a branch of Physical Science that deals with matter and energy and their interactions; and Chemistry is a branch of Physical Science that deals with the composition, structure, and properties of substances and with the transformations that they undergo.

In India, science is taught as Physical Science (Physics and Chemistry) and Biological Science till secondary school level. In this study, Physical Science refers to both Physics and Chemistry.

1.7.6 Attitude

According to ‘International Dictionary of Education’, the term ‘attitude’ may be defined as, “predisposition to perceive, feel or behave towards specific objects or
certain people in a particular manner.” Attitudes are thought to be derived from experience rather than innate characteristics, which suggest that they can be modified.

According to Webster’s Third New International Dictionary (1986), attitude is (1) a position or bearing as indicating action, feeling, or mood; (2) the feeling or mind itself; (3) a behavior representative of feeling or conviction; (4) a disposition that is primarily grounded in affect and emotion and is expressive of opinions rather than belief; (5) an organism’s state of readiness to act that is often accompanied by considerable affect and that may be activated by an appropriate stimulus into significant or meaningful behavior; (6) a persistent disposition to act either positively or negatively toward a person, group, object, situation, or value.

Le Roux (1994) defined attitude as, “a positive or negative emotional relationship with or predisposition toward an object, institution, or person.”

Pointing to yet another definition, Berckler and Wiggins (1991) defined attitude as, “enduring non-verbal features of social and physical world, and they are acquired through experience and exert a directive influence on behavior.”

These definitions suggest that attitude can be understood as an emotion that has an influence on the behavior of human beings. Attitude affects people in everything they do and in fact reflects what they are, and hence a determining factor of people’s behavior. Ajmen and Fishbein (1977) explained that by understanding an individual’s attitude towards something, one can predict with high precision the individual’s overall pattern of behavior to the object.

Therefore, the investigator’s operational definition of attitude is a predisposition to respond to a particular object (here, Physical Science and CAI) in a generally favourable or unfavourable way derived from a subject’s answers to a number of questions about it. In the present study, attitude of sampled students will be measured in terms of scores obtained on attitude scales constructed by the investigator.

1.7.6.1 Attitude towards Physical Science

It is an aggregate measure of a liking or disliking of Physical Science, a tendency to engage in or avoid activities in Physical Science, a belief that one is good or bad at Physical Science, and a belief that Physical Science is useful or useless.
Aiken (2000) defined attitude as ‘a learned disposition to respond positively or negatively to certain objects, situations, institutions, concepts or persons.’ Thus a student’s attitude towards science would be defined by his/her inclination to respond to the subject, or a particular aspect of the subject, in a certain predictable manner. Based on this definition, enjoyment of science, science anxiety, self-confidence, and perceived value of science can all be considered “attitudes”.

In this study, attitude towards Physical Science can be defined by students’ self-reported responses to items of five subscales, namely, enjoyment, anxiety, confidence, career in Science, and importance of Science.

Attitude towards Physical Science will be measured using attitude scale of Likert-type, developed by the investigator. It is administered on control and both experimental groups before and after the implementation of CAI.

1.7.6.2 Attitude towards CAI

Attitude towards CAI can be considered as a preference along a dimension of favourableness or unfavourableness to various aspects of CAI.

In this study, attitude towards CAI was defined by students’ self-reported perceptions on five subscales: Content Presentation, Assessment, Individualization, Integration, and perceived effectiveness.

Attitude towards CAI will be measured using attitude scale of Likert-type, developed by the investigator. It is administered to only experimental groups after the implementation of CAI.

1.7.7 Achievement in Physical Science

In the Standards for test construction (APA, 1999) achievement is viewed basically as the competence a person has in an area of content. This competence is the result of many intellectual and non-intellectual variables. At the experimental level, achievement is referred to as acquisition, learning, or knowledge representation, sometimes depending on theoretical biases. Achievement is the word preferred in the educational or psychometrics fields, being sometimes characterized by the degree of inference required on the part of the student to give a response, and by the type of reference to a cognitive process made explicit in the measurement tool. Achievement
refers to level of attainment in any or all science skills, usually estimated by performance on a test. Sometimes, it even refers to a person’s past learning.

According to Good (1973), the term ‘achievement’ may be defined as “accomplishment or proficiency of performance in a given skill or body of knowledge.”

According to ‘Dictionary of Education’, academic achievement is defined as “knowledge gained or skills developed in the school subjects, usually designated by test scores or by marks assigned by teachers, or by both.”

Glaser (1963) defined the measurement of student achievement as the determination of the characteristics of his performance with respect to specified standards.

It is a broadly used term in this study to indicate performance in Physical Science. ‘Achievement in Physical Science’ is operationally defined as a determination of the student’s work in science as measured by the achievement test. To measure achievement, Pretest-Posttest measure was used. This test was based upon the objectives underlying the CAI program that was used to deliver instruction to students. This Pretest-Posttest measure consists of 72 multiple-choice questions of varying levels of cognitive difficulty and is of 72 marks.

1.7.8 CAI Learning Environment

The classroom learning environment, sometimes referred to as the educational environment or the classroom climate, is the social atmosphere in which learning takes place (Johnson, 2004). Fraser (1994) regards these learning environments as the social-psychological contexts or determinants of learning. According to Wilson (1996), classroom learning environment is a place where learners and teachers interact with each other and use a variety of tools and information resources in their pursuit of learning activities. While observations of classroom teaching and learning and interviews with classroom teachers can provide valuable insights into the classroom learning environment, they do not tell the whole story. Students’ perceptions of the classroom learning environment are important, should be of interest to classroom teachers, and can be fairly easily measured with classroom environment perception instruments (Fraser, 2001).
Therefore, in this study, perceptions of CAI learning environment can be considered as a preference along a dimension of favourableness or unfavourableness to various aspects of CAI.

In this study, *perceptions of CAI learning environment were defined by students’ self-reported perceptions on three subscales of CAI learning environment scale developed by Askar, Koksal, and Yavuz (1991): cognitive, emotional, and interaction.*

### 1.8 Significance of the Study

This study is significant for a number of reasons. Firstly, it documents the implementation of CAI that secondary schools of India need in order to keep up with the ICT age we have entered. It supports research relating to the Ministry of Education guidelines (2007) within key curriculum areas. The results of this study could motivate and encourage further qualitative and quantitative research studies and inspire new significant research. Thus, it will attempt to provide unique baseline data on the effectiveness of CAI in Science teaching at secondary school level. Secondly, it will attempt to identify useful performance indicators with a view to developing a framework for good practice for CAI in schools throughout India. The third reason why the researcher chose this study is to explore the gender-wise differences in attitudes towards Science and whether these differences have any effect on the way in which they perceive their classroom environments. Knowledge of any differences, or similarities, between both perceptions of classroom environments and attitudes to Science by the two sexes, could prove helpful not only in course selection, counseling and developing positive interpersonal relationships between teachers and students, but also in ensuring gender equality.

There are several reasons why this study is important and distinctive for science teachers. Firstly, science teachers in India value students who have positive perceptions of their classroom environments and exhibit positive attitudes to science. These teachers anticipate that such students will not only perform well in their school years in this particular subject, but will also continue to go on to further studies in some area of Science. In turn, this could help them to make important and worthwhile contributions to the society in which they decide to live and work. Secondly, this study could help them to become aware of the factors that affect the perceptions of
students to their classroom environments, as well as the effect that these factors have on the formation of the attitudes of these students to this particular area of the school curriculum. Thirdly, the results of this study have the potential to encourage science teachers to incorporate the use of CAI in their classrooms as a viable alternative pedagogical approach. In particular, this study would provide valuable information that could help teachers and researchers in India to improve their pedagogical practices. The results of the present study have the potential to influence educators, researchers and curriculum developers to incorporate the use of CAI in the curriculum as a practical way to improve classroom environments, students’ attitudes towards Science and achievement. Moreover, this study is important because it is one of the first studies of computer assisted learning environment to be conducted in India. It also represents one of the few learning environment studies anywhere in Asia that focused on the effects of CAI on the classroom environment as perceived by students. Specifically, the study would provide information about the effects of CAI on students’ perception of their classroom learning environment and also their attitudes towards Science and achievement. It is likely to provide significant data to teachers and other researchers in regard to the implementation and uptake of CAI and explore the successes and challenges that are involved. The evidence that this research provides has the potential to influence decisions and choices that are made in relation to the educational curriculum at all levels.

1.9 Assumptions

For this study, the following assumptions were made:

1. The students were capable of answering the test items of achievement tests and describing their attitudes toward Physical Science and CAI as required by attitude scales used in this study. They would comprehend the items of attitude scales and achievement test.

2. A pretest-posttest measure assessing the instructional objectives of teaching the course contents, upon which CAI program was based, would accurately measure academic achievement.

3. The instruments (achievement tests and attitude scales) elicited the desired responses. Their responses to the items of attitude scales reflect their actual opinions.
4. It was assumed that the students know how to do all basic computer operations.

5. The students do not have had any experience of using the CAI software.

6. This study would provide students with a unique learning environment through CAI that will establish more interest and encouragement to learn science. The students, who were limited in their exposure to technology, would develop positive attitude towards the use of CAI in the Science classroom.

1.10 Delimitations

Like many studies, this study is delimited by certain circumstances. However, the delimitations are reasonable within the confines of any single research study and are not extensive so as to limit the contribution that can be made to the existing body of research on this topic.

1. The present study was delimited to only one English medium senior secondary school of Aligarh district in U.P., namely, Ayesha Tarin Modern Public School.

2. The sample of this study consisted of only those secondary school students enrolled in class X (session 2011-12).

3. The multimedia CAI software was used to teach only four chapters of Physical Science which are there in class X Science text book published by NCERT (National Council of Educational Research and Training).

4. The treatment or intervention lasted only for 2 months (8 weeks).

5. Data (particularly, on attitude towards Physical Science, CAI, and CAI learning environment) that were presented in this study were based on the participants’ attitudes and perceptions.