Chapter – I

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1.1 INTRODUCTION

Education is the process of instruction aimed to develop the knowledge, skill, attitude or character of individuals to prepare them to live a meaningful life. The strength of a nation depends upon how well educated its citizens are. It is education that makes a man rational; in fact, the training of human mind is not complete without it. Since ages, the society has viewed education as an important part of life. One of the most inevitable features of the society is that it continuously undergoes changes with time. From an agrarian age to an industrial age, the society has now entered into an information age. The pace of change has never been as fast as it is in the modern times. To adjust and accommodate itself to these transformations, change in societal values is automatic, which in turn necessitates a major shift in the methods of imparting and receiving education. To accomplish the main aim of education—preparing individuals to be contributing and productive citizens—in this era of modern technology and fast-paced change, education must center on teaching individuals to think critically and creatively.

Robinson states in her 1987 practicum report: Teaching children to become effective thinkers is increasingly recognized as an immediate goal of education.... If students are to function successfully in a highly technical society, then they must be equipped with lifelong learning and thinking skills necessary to acquire and process information in an ever-changing world. According to Fiske (1998), technology has the ability not only to incorporate the essential content of instruction, but also to move students to higher-order thinking and teach life-long learning skills.

As a result of newfound technological advancements both in the fields of computer technology and instructional technology, contemporary educational
courses are designed not only to assist students to develop personal autonomy, social competence, and creative capacity and but also to stimulate appreciation of the finer things in life. Demands upon and within the educational sectors are changing. For higher education, demographics and workforce changes are fundamentally altering the student population. Today’s student’s lifestyle and objectives are also very different from those of yesteryear. The same person may want to pursue higher education, but may be unable to do so as a result of time commitments and constraints that are usually required in institutions of higher learning. Additionally, we find that many students do not have specific available time blocks, which they can reserve or allocate to a particular course or educational unit of instruction (Kadlubowski, 2000).

In traditional education, students belong to only one school and passively learn from teachers through information transmission such as lectures and classroom demonstrations, along with a few opportunities for active participation. Traditional approaches to education are not effective enough to prepare citizens to cope with the complicated problems of the changing societies of the 21st century. Students need to develop the skills that will enable them to become lifelong learners. Using information and communications technology, we could overcome borders of countries, universities, schools and academic subjects, and also barriers of even time and location (Sakamoto, 1999).

With the introduction of new educational technologies, it is now possible to teach and learn beyond the boundaries of the traditional classrooms. The ever-increasing number of aspirants seeking education has posed a challenge of keeping large groups in and outside the classrooms motivated to perform to their fullest potential. This seemingly difficult objective can be best achieved by incorporating new educational techniques and devices in both teaching and learning. Innovations in multimedia and computer-related technology offer exciting opportunities to impart quality education to students. One of the most powerful uses of technology in education has been to tailor instruction to students’ individual learning needs.
Symonds (2000) stated that technology can be a crucial tool to improve student learning. He pointed out that the quality of public education could be improved by utilizing the Web to individualize instruction, creating learning opportunities for teachers to engage in collegial support via e-mail, and facilitating better home-school communication through e-mail and Website information.

Haddad and Jurich (2000) concluded that the integration of modern information and communication technologies (ICTs) into the teaching/learning process of science and mathematics has great scope. Presenting material through multimedia enhances critical thinking and other higher levels of cognitive skills, and provides access to worldwide information resources. Videos, television, and computer multimedia software are excellent instructional aids to engage students in the learning process. By using sound, color and movement, the technologies stimulate the students’ sensorial apparatus and make the learning process enjoyable and interesting.

There has been a dramatic increase in the capabilities of computers, along with reduced cost, that has influenced an increase in the various forms of computer-delivered instruction (Brown, 2001). This increase has been seen in education as well as in other disciplines (Passerini, 2000). Throughout the 1980’s and 90’s computers have been generally heralded as being an effective teaching methodology (Christmann & Badgett, 2000).

The Software Publishers Association (SPA) commissioned an independent meta-analysis of 176 studies focusing on the effectiveness of technology in schools. This report concludes that the use of technology as a learning tool can make a significant difference in, amongst other things, student achievement as measured by standardized tests (Sivin-Kachala & Bialo, 1996). In a study conducted by McKinnon et al. (1996) in New Zealand with eighth, ninth, and tenth-grade students, researchers found that the use of computers contributed, with other instructional innovations, in higher performance on English, Mathematics, and Science tests. An extensive study of 55 New York State school districts performed
by Mann and Shafer (1997) pointed towards the same conclusion: increased technology supports, facilitates, and encourages student achievement.

In numerous studies of students learning with technology, teachers have reported that it encourages them to be more student-centered, more open to multiple perspectives on problems, and more willing to experiment in their teaching (Knapp & Glenn, 1996). A variety of studies suggest that, over time, technology can serve as a strong catalyst for change at the classroom, school, and district level (Hawkins et al., 1996; Means, 1994; Chang et al., 1998).

Gibbons and Fairweather (1998) proposed that by using computers, teachers can expect students to interact with more complex materials. They also stated that computers allow teachers to act more as coaches and facilitators using a learner-centered style of teaching.

Silverstein et al. (2000) concluded that technology can provide the means for students with special needs to communicate via e-mail, and to use internet for research. It can also help teachers to accommodate students’ varying learning styles.

Based on various research studies, Roblyer (2003) compiled a list of reasons why technology should be used in education. Elements of a Rationale for Using Technology in Education are as follows:

a. Technology provides motivation for students by:
   - Gaining learner attention
   - Engaging the learner through production work
   - Increasing perceptions of control

b. Technology offers unique instructional capabilities, such as:
   - Linking learners to information and educational resources
   - Helping learners visualize problems and solutions
   - Tracking learner progress
• Linking learners to learning tools
c. Technology gives support for new instructional approaches, such as:
  • Cooperative learning
  • Shared intelligence
  • Problem solving and higher level skills
d. Technology increased teacher productivity by:
  •Freeing time to work with students by helping with production and record-keeping tasks
  • Providing more accurate information more quickly
  • Allowing teachers to produce better looking, more “student-friendly” materials more quickly
e. Technology skills are required for an information age:
  • Technology literacy
  • Information literacy
  • Visual literacy

In light of the above findings, it is incumbent upon educators to combine and integrate the new tools, models and techniques of teaching with traditional methods that will not only acknowledge each student’s individual learning needs but will also help ensure that each student has the opportunity to become a lifelong learner and achiever. The present research study has investigated the significance of multimedia presentations and computer assisted instruction over the traditional lecture method as instructional strategies.

1.2 MULTIMEDIA PRESENTATION (MMP)
1.2.1 Historical Perspective
As multimedia is the combination of various media, it will be appropriate to trace back their inventions. Text in the form of printed books came into existence after the Printing Press was invented in 16th century. The technology of developing photos and videos was invented in the 19th century followed by the development
of digital and interactive media including computers in 20th century. The first electronic digital computer ENIAC (Electronic Numerical Integrator and Computer) was invented in 1946. The computer was introduced for the first time in schools in 1959. Multimedia is not really a new technology. In 1965 the term Multi-media was used to describe the ‘Exploding Plastic Inevitable’, a performance that combined live rock music, cinema, experimental lighting and performance art. In the intervening forty two years the word has taken on different meanings due to expansion of its usage especially for educational purposes. In the late 1970s the term was used to describe presentations consisting of multi-projector slide shows timed to an audio track. In the 1990s it took on its current meaning. Some computers which were marketed in the 1990s were called "multimedia” computers because they incorporated a CD-ROM drive, which allowed for the delivery of several hundred megabytes of video, picture, and audio data. Today, multimedia implies the integrated use of multiple media and various technologies, such as slides, video and audio tapes, texts, records, CD-ROMs, and photos, to generate one complete project in such a way that can be accessed interactively. Much of the content on the web today falls within this definition as understood by millions. “Tell me and I forget. Show me and I remember. Involve me and I understand.” This ancient proverb epitomizes the concept on which multimedia education is founded i.e. learning is enhanced by stimulating multiple senses simultaneously. Studies have concurred that people retain only 20% of what they see but they remember as much as 80% of what they see, hear, and do simultaneously. The combined use of tools and technologies during multimedia instruction enhances learning by stimulating multiple sensory organs simultaneously and also by enabling the elegant explanation of learning objects. Studies focused on the effectiveness of multimedia education have proven that multi-medial learning resources are often more effective than text-only resources, particularly when the learner is introduced to completely new material (Dervan et al., 2006; Otto, 1994; The Encyclopedia of Educational Technology, 2008; Vaughan, 1993).
1.2.2 Meaning of MMP

Multimedia literally means integrating two or more types of media for a presentation. Multimedia has been defined in a number of ways. In order to clarify the use of the term in education, a few definitions are quoted below.

Multimedia is commonly defined as the combination of text, graphics, audio, video, and animation on a computer (Fox, 1991).

The term 'multimedia' describes a new application-oriented technology that is based on the multi-sensory nature of humans and the evolving ability of computers to convey diverse types of information (Little, 1991).

Multimedia is a method of designing and integrating computer technologies on a single platform that enables the end-user to input, create, manipulate and output text, graphics, audio and video, using a single user interface (Strothman, 1991).

Multimedia is any combination of text, graphic art, sound, animation, and video delivered to you by computer or other electronic means (Vaughan, 1993).

Multimedia is the combination of a variety of communication channels into a coordinated communicative experience for which an integrated cross-channel language of interpretation does not exist (Elsom-Cook, 2001).

Multimedia can be defined as an integration of multiple media elements (audio, video, graphics, text, animation, etc.) into one synergetic and symbiotic whole that results in more benefits for the end user than any one of the media elements can provide individually (Reddi, 2003).

So in simple words, multimedia is a combination of computer technologies involving texts, images (including video), graphics, and sounds and multimedia presentation refers to the presentation of information by making integrated use of multiple forms of media and technologies. It usually allows a user to seek information and construct knowledge in a variety of ways, and it frequently relies
on problem solving as a basis for understanding—using images and video of real world experiences to help illustrate abstract principles and concepts.

1.2.3 Types of MMP

There are numerous types of multimedia. Main types of multimedia forms that are used as instructional tool in education are given below.

**Web Pages:** A Web page or webpage is a resource of information that is suitable for the World Wide Web and can be accessed through a web browser. A web page is a type of web document. A web page, as an information set, can contain many kinds of information, which is able to be seen, heard or interact by the end user. Web pages become multimedia resources and presentations when they are designed with media other than static images and text such as audio, video, animation and virtual reality.

**Hypermedia:** Hypermedia refers to hyperlinked multimedia—the linkage of text, audio, graphics, animation, and/or video through hyperlinks. For example, a hypermedia study guide might offer illustrated textbook content hyperlinked to web-based video and other content, glossary entries, and comprehension questions. Other hypermedia applications for the classroom include supported digital reading environments and lessons. Hypermedia offers a powerful means to integrate curriculum content with instructional supports and address varied student needs. Digital texts can be enriched with a range of instructional supports such as vocabulary definitions, glossaries, translations, explanatory notes, background information, and instructional prompts.

**Slide Presentations:** Teacher or student slide presentations can be done using a variety of software such as PowerPoint, AppleWorks Presentation, Corel Presentations 8.0 and KidPix Slide Show. Slide show presentations can be viewed by a group at the computer or by a class by connecting the computer to a digital projector. PowerPoint Presentation is widely used in class rooms. PowerPoint is an electronic slide show that can be used in conjunction with the class lecture. Test, charts, graphs, audio, text animation, live hyperlinks and video clips can be added.
to the presentation to enhance its educational potential. PowerPoint comes with several templates ready for the presenter to add text, graphics, and even digital videos for display. The advantage of using PowerPoint for presentations is that once the presentation is prepared for class, it can be presented from a computer, printed for use as transparencies or handouts. Then it can be saved to HTML (web format) with only a few clicks of the mouse. PowerPoint takes care of creating all the pages and navigation buttons. Teachers can provide students with their lecture for review at anytime.

**Video:** Video presentations not only can provide background information in a unit of study for all learners but a resource for independent learning also. Documentary videos help students gain insight to historical events, other cultures and human identities. Videos can also provide the window to the remote - outer space, the inaccessible biological structures and events, for instance, - the human heart, and - a bee pollinating a flower.

**Computer Simulations:** Computer simulations are computer-generated versions of real-world objects (for example, a brain) or processes (for example, an election). They may be fully automated or interactive, eliciting user input. Computer simulations are a means to "open up the walls of the classroom," providing students with an opportunity to observe, manipulate, and investigate phenomena that are normally inaccessible—an orbiting satellite or foreign culture—using tools and materials that are not available in the classroom. In this respect, they provide an advantageous alternative to learning that might otherwise rely on lecture and printed text. Not only do simulations reduce barriers for students who struggle with these conventional media, they provide multiple models for skill learning, and can increase the immediacy and authenticity of learning content, which is advantageous to many learners. Computer simulations can be used to increase content knowledge and to develop skills. Computer simulations are available on the web, as well as in software form.
1.2.4 Effectiveness of MMP

A multimedia presentation allows the educator to present more information, more examples, illustrations, and problems for students to solve than the conventional instructional method. It can take course material that was once contained in lectures and reshape it so that students see and hear the actual events that they otherwise would only hear about. It can also demonstrate concepts that could not easily be demonstrated in a lecture hall or classroom.

Over a decade ago, Sheingold (1990) pointed out that integrating technology in schools and classrooms is not so much about helping people to operate machines as it is about helping teachers integrate technology as a tool of the profession. Sheingold added that the teaching profession is being redefined as a result of this incorporation or integration process. When effectively integrated in classrooms, technology should provide teachers with the appropriate tools, resources, and contexts to improve students’ abilities to become active learners who seek to understand complex subject matter and who are better prepared to transfer what they have learned to new problems and contexts.

Hofstetter (1993) stated that using integrated media for presentations can allow teachers to literally bring the world to the classroom with the stroke of a key and link text to other text, still pictures, dynamic video, audio clips, or to networks anywhere in the world, just to name a few possibilities.

According to Buckley et al. (1999), multimedia is becoming an important tool for faculty in the biological sciences due to increasing conceptual and functional complexity that presents educational challenges that cannot be adequately addressed with traditional teaching methods.

Vacca and Vacca (1999) described some of the basic concepts for integrating multimedia into classroom activities:
• Interactivity- students are capable of manipulating texts, and text is responsive to student’s interests, purposes, and needs.

• Communication- telecommunication networks enhance electronic text interaction with others throughout the world.

• Information search and retrieval- a wide range of information resources and search capabilities enhance student research and information gathering.

• Multimedia environments- images, sound, and text are highly engaging and extend students’ understanding.

• Socially mediated learning- students collaboratively construct meaning as part of literacy learning.

The promise of multimedia learning is that, by combining pictures with words, we will be able to foster deeper learning in students. First, multimedia instruction messages can be designed in ways that are consistent with how people learn, and thus can serve as aids to human learning (Mayer, 1997, 1999a, 1999b, 2001). Second, there is a growing research base showing that students learn more deeply from well designed multimedia presentations than from traditional verbal-only messages, including improved performance on tests of problem-solving transfer (Mandl & Levin, 1989; Mayer, 2001; Najjar, 1998; Schnotz & Kulhavy, 1994; Sweller, 1999; Van Merriënboer, 1997). In short, the promise of multimedia learning is that teachers can tap the power of visual and verbal forms of expression in the service of promoting student understanding.

Many recent studies indicate that computer-based multimedia can improve learning and retention of material presented during a class session or individual study period, as compared to “traditional” lectures or study materials that do not use multimedia (Bagui, 1998; Fletcher, 2003; Mayer, 2001). According to Najjar (1996), this improvement can be attributed mainly to dual coding of the information presented in two different modalities—visual plus auditory, for example (Clark & Paivio, 1991; Paivio, 1986)—leading to increased
comprehension of the material during the class session, and improved retention of the material at later testing times (Mayer & Moreno, 1998).

There is general agreement that multimedia presentations are most effective when the different types of media support one another rather than when superfluous sounds or images are presented for entertainment value—which may induce disorientation and cognitive overload that could interfere with learning rather than enhance learning (Mayer et al., 2001).

Bockholt et al. (2003) constructed a student centered instructional module on Cancer Cell Biology. On the basis of the student feedback, they concluded that multimedia had the potential of providing bioscience education novel learning environments and pedagogy applications to foster student interest, involved students in the research process, advance critical thinking/problem-solving skills, and developed conceptual understanding of biological topics. They found that the co evolution of information and communication technologies with teaching and learning methods presents unique opportunities for multimedia to have a profound impact upon teaching and learning.

Astleitner and Wiesner (2004) have suggested that student satisfaction and motivation is higher in courses that use multimedia materials.

Multimedia can help to gain and hold attention, make points clearer, stimulate discussion, and in general, enhance the learning process, if it also includes the appropriate human elements. Multimedia is not meant to replace instructors, nor can it replace them. Instead, multimedia is meant to help faculty teach in ways they may have never imagined. Today's students have grown up with multimedia, and expect to learn using many methods besides traditional lecture ("chalk & talk"). In addition, multimedia allows students to experience a subject from many angles, giving them a deeper understanding of the subject matter. Using various forms of multimedia in the classroom also helps to keep interest levels high (Information Technology and Communication, 2008).
Because multimedia technology exists in such a diverse array of interactive and stimulating material, its integration into science curriculum offers a wide variety of learning possibilities for students as well as teachers. A multimedia presentation, thus, can be used as an effective tool to assist educators in making a shift from purely text-based drill-and-practice exercises to rich, complex teaching resources that utilize text- and image-based communication. Multimedia can be beneficial when it is carefully designed and does not overload human information processing unnecessarily.

1.3 COMPUTER ASSISTED INSTRUCTION (CAI)

1.3.1 Historical Perspective

Computer assisted instruction was introduced for educational purposes in 1960s, mostly for the teaching of basic mathematics skills. However, according to Frenzel (1980), its origins are traceable to a machine designed to grade multi-choice exams that was invented in 1924 by Dr. Sidney Pressey. During the late 1950s and early 1960s, the work of B. F. Skinner and others in the area of teaching machines and programmed instruction improved and expanded upon Pressey's work. In the late 1960s came the discovery that programmed instruction could be implemented via computer.

During the 1960s, the computer-assisted instruction was developed and used at a few universities, military training centre and corporations in the United States. The early efforts were found to be focused to provide individualized interactive instruction to many learners simultaneously (Van der Linden, 1995). Hall (1971) pointed out that computer-assisted programmes before the mid-1960s were built around modified business computers and terminals and were not appropriate for instructional purposes. In 1966, IBM developed the first computer system specifically for instructional purposes, the 1500 Instructional System. With the introduction of the minicomputer and the development of a project called PLATO (Programmed Logic for Automatic Teaching Operation) during the late 1960s and early 1970s, a new round of interest in CAI was initiated. A computer-based educational network, the PLATO was one of the largest and perhaps most
sophisticated computer systems designed for education which demonstrated for the first time that CAI could be beneficial to students. Another major project dominating the field of CAI, Time Shared Interactive Computer Controlled Information Television (TICCT) was developed in 1972. In 1975, the Computer Curriculum Corporation (CCC) was developed to offer a large variety of courses for elementary through junior college students (Alderman et al., 1978; Alessi & Trollip, 1991; Kulik et al., 1980; Magidson, 1978; Suppes & Macken, 1978).

The first President of Computer Curriculum Corporation (CCC), Prof. Patric Suppes led an extensive research and development efforts that earned him the honorary title “Grandfather of Computer Assisted Instruction”. Suppes developed CAI at Stanford University for one of the first mini computers in 1966. Microcomputers came in to the American classrooms in 1977, thus shifting interest from mainframe computers to microcomputers (Campbell, 2000; Roblyer & Edwards, 2000). Frenzel (1980) emphasized that due to the cost and the size of computers available during the 1960s, large-scale implementation of CAI projects was not possible; but with the advent of large-scale integrated (LSI) circuits and the introduction of personal microcomputers, the cost of CAI computing is no longer prohibitive. As a result, there is currently a resurgent interest in the application of computers in education. At present, CAI is being used for diverse subject matters, including foreign language teaching.

1.3.2 Meaning of CAI

As the name implies, the basic interaction in Computer Assisted Instruction (CAI) occurs between the learner and the computer. It is self paced and in many respects is very similar to programmed learning except that the instructional package is in the form of computer programme. Instruction usually proceeds step by step using a video display. The learner answers questions and calls up the next learning sequence by using the computer terminal. The system is more interactive than programme instruction because the learner can select from a wider range of options and can be required to make more complex decisions (Farooq, 1997).
The literature related to CAI includes an array of definitions describing the meaning of the term. Association for Education Communications and Technology (1977) has defined computer-assisted instruction (CAI) as a method of instruction in which the computer is used to instruct the student and where the computer contains the instruction which is designed to teach, guide, and test the student until a desired level of proficiency is attained.

Frenzel (1980) described and defined CAI as the process by which written and visual information is presented in a logical sequence to a student by a computer. The computer serves as an audiovisual device. The students learn by reading the text material presented or by observing the graphic information displayed. The primary advantage of the computer over other audio-visual devices is the automatic interaction and feedback that the computer can provide. Multiple paths through the course material can be taken depending upon the individual student's progress.

Bucholtz (1999) adds new meaning to CAI by using this term for internet based instruction through the use of web pages, web bulletin boards and real audio, graphics and hands-on application.

Lowe (2001) defines computer-based education as the process or management of instruction that uses a microcomputer as the medium.

UNESCO: IBE Education Thesaurus (6th Edition, 2002) defines CAI as an interactive learning method in which a computer is used to present instructional material, monitor learning and select additional material in accordance with individual learner needs.

According to Sci-Tech Dictionary (2003), Computer Assisted Instruction is the use of computers to present drills, practice exercises, and tutorial sequences to the student, and sometimes to engage the student in a dialogue about the substance of the instruction. It is also known as Computer Aided instruction and Computer Assisted Learning (CAL).
Some definitions are as simple as the one given in Encyclopedia Britannica (2008) which defines computer-assisted instruction as a program of instructional material presented by means of a computer or computer systems.

By drawing meaning from a range of definitions given by educators and researchers, Computer Assisted Instruction (CAI) can be described in simple words as an interactive instructional method that uses a computer to present material, track learning, and direct the user to additional material which meets the student’s needs. CAI learning uses a combination of text, graphics, sound and video in the learning process.

1.3.3 Types of CAI

Computer Assisted Instruction (CAI) involves using the computer in a classroom-teaching role. Specific course objectives are addressed through the unique instructional format that the computer offers. Out of many teaching strategies that are grouped as CAI, the four main categories are drill-and-practice, tutorial, simulations and games.

**Drill & Practice:** As an instructional strategy, drill & practice is simplest form of CAI. As the name suggests, drill and practice software gives a learner repeated opportunity to practice a specific skill thus acts as a reinforcement tool. It is not designed to present new material or to introduce the students to new concepts, but to simply reinforce, through review and practice, topics to which the student has already been exposed. Drill and Practice activities help learner’s master materials at their own pace. Good drill and practice provides feedback and explains how to get the correct answer. The purpose of drill and practice software is to have the learner memorize information. The program presents a question to the learner, the learner responds, and the software then gives feedback as to whether the answer is correct or incorrect. The curricular applications for drill and practice software include any area where basic skill mastery is desired. Memorization of math facts, grammar practice, and foreign language vocabulary practice are examples of appropriate use of this software.
**Tutorial:** In this form of CAI, the computer assumes the role of a tutor -- assessing the learner's skill, then presenting new instruction, providing practice, asking a question and, depending on the learner's response, either remediates by re-teaching, or moving on to the next level. Tutorials are used to introduce new content to learners in much the same manner that a human teacher might do. Tutorial software, like drill and practice, has value to the learner in that it allows the learner to answer every question, proceed at her/his own pace, and provides privacy of feedback. Curricular applications for tutorial software are broad. Tutorials can be used in language instruction, mathematics, and even writing. Most software programs come with built-in tutorials that help show the learner how to navigate through the program.

**Instructional games:** These games offer a programmed environment by which the student can play, experiment and learn from mistakes and feedback. These games are very similar to drill and practice or simulation but are modified to include gaming elements. Instructional games can accelerate learning, retention, and transfer of learning. There is an end goal to be achieved following the rules of play. In addition to the sensory appeal, instructional games also have motivational elements which include elements of competition or challenge wherein players compete against themselves, against other individuals, or against an objective standard. Students are actively involved and social interaction is encouraged through the necessary communication among players. They can be incorporated into many instructional situations in order to increase student motivation and levels of effort for specific learning tasks.

**Simulation:** It is a computerized model of a real or imagined system designed to teach how a system works. This type of software presents a situation to the learner, the learner makes a choice, and the software responds to that choice by taking one of several paths. Simulations differ from tutorial and drill and practice activities by providing learner structured activities. Educational simulations provide the opportunities to students for applying knowledge in a realistic format and allow students to experience events, or phenomena that they are not able to witness
personally but without the time, expense, or risk associated with the real thing. Software can simulate manipulating objects, performing a set of procedures or acting in a given situation. The person using the courseware usually chooses tasks and the order in which to do them. He can also control the speed of processes to study the effects. Curricular applications for simulation software are extensive. They are often used in science, particularly for laboratory experiments. Social studies is another area in which simulations are applicable. Math students can simulate graphs and other functions through use of simulations, and in graphic design, cars and houses can be constructed using computer simulation software.


1.3.4 Characteristics of CAI

Programmed Learning, Computer Based Instruction (CBI), and Computer Assisted Instruction (CAI) have been used as alternative teaching strategies for number years to achieve positive learning outcomes. These systems have the distinct advantage of being able to accommodate for the individual needs of the student both in terms of the material covered and the time that it takes for the student to learn the material. The essential characteristics that make CAI as a self learning module suitable to enhance learning are as follows:

- **Defining learning objectives clearly:** Schank (1998) reports that learners need a road map of the lesson plan. Similar to a classroom setting where effective lecturers define their terms early in the course, the first essential feature of CAI module is to define the learning objectives so that the learner knows about the expected learning outcomes in the beginning. Objectives help the learner understand the overall purpose of the instruction.

- **Assessing pre-requisite knowledge of the learner:** One viewpoint from the cognitive learning theorist is that new knowledge is learned by the merging of previous knowledge with new information
(Hannafin & Peck, 1988). In order to assess previous knowledge that the learner should acquire prior to beginning this tutorial, a set of questions have to be included.

- **Self-contained**: CAI module being self-contained gives the learner opportunity to use it individually.

- **Presentation of the content in sequential and organized manner**: Kristof and Satran (1995) indicate that realization of the goals is best accomplished through simple, clear presentation of content that provides remediation when deemed necessary by the user. The input must be given in small steps within an organized framework linking the new information with the previous one.

- **Testing and Feedback**: To test the acquisition of information by the learner, CAI module includes practice exercises which require the learner to apply the knowledge he gained so far. The feedback on response given by him/her, the correction is provided which facilitates enhanced learning.

- **Providing Self Pacing and Redundancy**: According to Abedor (1978), “Pacing is the rate at which the information is presented, while redundancy is the degree of repetition of ideas in a given instructional sequence.” CAI module provides learner the freedom to precede at the pace according to his/her individual learning level. It also provides frequent reviews or summaries, of the information covered, frequent practice tasks and feedback. The developer has to take care of the fact that excessive repetition of the information tends to make it boring.

- **Allowing the learner to interact**: One way to keep users engaged is to make them an active part of the learning process rather than passive recipients (Schank, 1993). Thus, a successful CAI module must have a high level of interactivity in order to maintain user interest and therefore
successfully achieve its learning goals. The user’s main interaction and learning control lies in his or her ability to navigate the content. Navigation must provide direct access, with a minimal number of steps between content, yet at the same time not overwhelm users with an excessive number of navigation options. (Lux & Davidson, 2003).

- **Gaining attention and sustaining the motivational level:** Appropriate Graphics and sounds must supplement the content not only to catch attention of the learner but also to emphasize the concept. Pictures, illustrations, animations, flash movies etc. stimulate the sensorial apparatus of the learner and help augment the comprehension of many concepts. By providing a variety of learning experiences, the module can sustain the motivational level of the learner. Lux and Davidson (2003) suggest that a graphically embellished screen design should be avoided, i.e., the excessive use of loud or contrasting colors, patterned backgrounds, and/or animated features may distract the learner from both the content and the learning goals.

### 1.3.5 Effectiveness of CAI

According to Frenzel (1980), the primary advantage of CAI over traditional classroom teaching methods appears to be the automatic interaction and immediate feedback that the computer can provide to students on an individual basis.

Capper and Copple (1985) concluded that CAI users sometimes learn as much as 40 percent faster than those receiving traditional, and teacher-directed instruction, retention of content is superior to traditional instruction alone. Research has also shown improvements in other variables such as locus of control, attendance, motivation, and cooperation.

Investigations by various researchers have revealed the following points given by students for liking CAI activities and/or favoring them over traditional learning. Students say they like working with computers because computers:
• Are infinitely patient and never get frustrated or angry
• Never get tired
• Allow students to work privately
• Never forget to correct or praise
• Are fun and entertaining
• Individualize learning
• Are self-paced
• Do not embarrass students who make mistakes
• Make it possible to experiment with different options
• Give immediate feedback
• Are more objective than teachers
• Free teachers for more meaningful contact with students
• Are impartial to race or ethnicity
• Are great motivators
• Give a sense of control over learning
• Are excellent for drill and practice
• Call for using sight, hearing, and touch
• Teach in small increments
• Help students improve their spelling
• Build proficiency in computer use, which will be valuable later in life
• Eliminate the drudgery of doing certain learning activities by hand (e.g., drawing graphs)
• Work rapidly--closer to the rate of human thought.

(Bialo & Sivin-Kachala, 1990; Braun, 1990; Lawton & Gerschner, 1982; Mokros & Tinker, 1987; Robertson, et al.1987; Rupe, 1986.)

Research studies also indicate that when students interact with the computers they become inquisitive and creative with an increase in their level of intrinsic
motivation as a result of acquisition of the freedom to take over their own learning (Armour-Thomas, 1992; Ganguli, 1992; Gatto, 1993, Lehman, 1994; Maorr & Fraser, 1994; Wang & Sleemen, 1993).

CAI has the potential as an instructional medium to individualize the learning process. It may be more beneficial to some learners than others. For example, graphics and visually active instruction helps field dependent learners. Motivated learners, who require specific instruction in a sequential format and enjoy frequent feedback, will generally benefit for CAI (Lin & Davidson, 1996; Rasmussen & Davidson-Shivers, 1998).

Haddad and Jurich (2000) stated that CAI profits from three advantages of technology over the human brain: speed, memory power, and the capability to repeat tasks indefinitely without reducing performance. These programs offer students the opportunity to practice basic skills in their own time and pace. They function as automated tutors, presenting a hierarchy of concepts and skills that students need to master before they are allowed to proceed to the next level. Generally, the material is divided into modules of increasing difficulty. Students are evaluated at the end of each module, receiving an immediate feedback.

Increased accountability has put more pressure on teachers to meet curriculum outcomes and to ensure student performance (Marshall & Hillman, 2000). Lowe (2001) says that computer-based education provides an alternative way for learners to reach their goals independently in self-directed and self-paced learning experience.

In a study conducted by Traynor (2003) to determine how computer-assisted-instruction improves student performance among 161 middle school students of various program types, the results indicated that the computer-assisted-instruction program increased overall student learning. He suggested that computer-assisted instruction affects cognitive processes and increases motivation by the following ways:
• Personalizing information
• Animating objects on the screen
• Providing practice activities that incorporate challenges and curiosity
• Providing a fantasy context
• Providing a learner with choice over his/her own learning

In particular, computer programs may be especially beneficial for low performing students by providing the opportunity for ample practice of skills (Macaruso et al., 2006a; Torgesen & Barker, 1995; Wise et al., 2000).

The future of computer technology is undoubtedly a powerful vehicle for changing teaching and learning in education and CAI is a promising tool to achieve cognitive objectives more effectively.

1.4 COGNITIVE STYLE

Cognitive style refers to the way a learner organizes, filters, transforms, and processes information. A person's cognitive style is determined by the way in which a person takes in the environment in which he/she is embedded. Messick (1976) considered cognitive style a psychological term which refers to variations among individuals in preferred ways of perceiving, organizing, analyzing, or recalling information and experience. Green (1985) defines cognitive style as consistencies in the ways in which people perceive, think, respond to others, and react to their environment.

Educators and researchers have long recognized the unique differences among individuals and the impact of these differences can have on learning. Concern for these differences led to research on the cognitive variables or cognitive style that individuals posses. There are a number of approaches to cognitive styles that have been proposed. These include field dependence/independence, simultaneous and successive processing, focusing/scanning, reflective/impulsive, leveling/sharpening, narrow/broad categorizing, active/reflective thinking, etc. With nearly 4,000 references in the literature, field dependence/independence (FDI),
introduced in 1954 by Herman Witkin has received the most attention by researchers of all the cognitive styles (Chinien & Boutin, 1993; Entwistle, 1981; Kent-Davis & Cochran, 1989; Witkin & Goodenough, 1981).

Goodenough (1976) suggested a cue salience hypothesis to explain field independents consistently higher performance on concept-attainment tasks. Goodenough contends that field-dependent learners attend to the most vivid or salient features of a stimulus, tending to overlook other features that may be more relevant to task performance.

In their reviews of the field dependence/independence literature Goodenough (1976) and Witkin, et al. (1977) drew several conclusions about the strategies and approaches taken by field dependents and field independents in learning situations. They contend that field independents tend to adopt an analytical approach to problem-solving, sample more cues inherent in the field, and are able to extract the relevant cues necessary for completion of a task. Field dependents take a passive approach, are less discriminating, and attend to the most salient cues regardless of their relevancy.

According to Witkin and Goodenough (1981), field dependent learners are more socially oriented than field independent learners. They pay more attention to social cues; they like to be with others; and they seek learning and vocational experiences that put them in contact with people. Korchin (1982) reported that field-independent individuals have a greater aptitude for cognitive restructuring. They also function autonomously and are likely to be impersonal and often described as cold, manipulating, and distant. Brodzinsky (1985) concluded that field dependent children perform less well on formal operations tasks than do field independent children.

Garger and Guild (1987) have summarized the characteristics of field independent and field dependent learners as follows in Table 1.1.
### Table 1.1: Field Independence / Field Dependence Descriptions

#### Learning Styles

<table>
<thead>
<tr>
<th>FIELD-DEPENDENT</th>
<th>FIELD-INDEPENDENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceives globally</td>
<td>Perceives analytically</td>
</tr>
<tr>
<td>Experiences in a global fashion, adheres to structures as given</td>
<td>Experiences in an articulate fashion, imposes structures of restrictions</td>
</tr>
<tr>
<td>Makes broad general distinctions among concepts, sees relationships</td>
<td>Makes specific concept distinctions, little overlap</td>
</tr>
<tr>
<td>Social orientation</td>
<td>Impersonal orientation</td>
</tr>
<tr>
<td>Learns material with social content best</td>
<td>Learns social material only as an intentional task</td>
</tr>
<tr>
<td>Attends best to material relevant to own experience</td>
<td>Interested in new concepts for their own sake</td>
</tr>
<tr>
<td>Requires externally defined goals and reinforcements</td>
<td>Has self-defined goals and reinforcements</td>
</tr>
<tr>
<td>Needs organization provided</td>
<td>Can self-structure situations</td>
</tr>
<tr>
<td>More affected by criticism</td>
<td>Less affected by criticism</td>
</tr>
<tr>
<td>Uses spectator approach for concept attainment</td>
<td>Uses hypothesis-testing approach to attain concepts</td>
</tr>
</tbody>
</table>

#### Teaching Styles

<table>
<thead>
<tr>
<th>FIELD-DEPENDENT</th>
<th>FIELD-INDEPENDENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prefers teaching situations that allow interaction and discussion with students</td>
<td>Prefers impersonal teaching situations such as lectures. Emphasizes cognitive aspects of instruction.</td>
</tr>
<tr>
<td>Uses questions to check on student learning following instruction</td>
<td>Uses questions to introduce topics and following student answers</td>
</tr>
<tr>
<td>Uses student-centered activities</td>
<td>Uses a teacher-organized learning situation</td>
</tr>
<tr>
<td>Viewed by students as teaching facts</td>
<td>Viewed by students as encouraging to apply principles</td>
</tr>
<tr>
<td>Provides less feedback, avoids negative evaluation</td>
<td>Gives corrective feedback, uses negative evaluation</td>
</tr>
</tbody>
</table>
Strong in establishing a warm and personal learning environment
Strong in organizing and guiding student learning

How to Motivate Students

<table>
<thead>
<tr>
<th>FIELD-DEPENDENT</th>
<th>FIELD-INDEPENDENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Through verbal praise</td>
<td>Through grades</td>
</tr>
<tr>
<td>Through helping the teacher</td>
<td>Through competition</td>
</tr>
<tr>
<td>Through external rewards (stars, stickers, prizes)</td>
<td>Through choice of activities, personal goal chart</td>
</tr>
<tr>
<td>Through showing the task's value to other people</td>
<td>Through showing how the task is valuable to them</td>
</tr>
<tr>
<td>Through providing outlines and structure</td>
<td>Through freedom to design their own structure</td>
</tr>
</tbody>
</table>

From Table 1.1, we can see some of the relationships to the field dependence/field independence variable which have an impact on learning. Both the responses of the student in the teaching area and in the ways they are motivated are very different for the two ends of the continuum.

Riding and Cheema (1991) found over thirty different labels of cognitive style represented in the literature by different theorists. After an extensive review they concluded that these could be fundamentally grouped into the two dimensions of the ‘wholist-analytic’ style, which differentiates whether an individual processes information as a whole or in parts, and the ‘verbal-imagery’ style, which differentiates whether someone tends to internally represent information verbally or in pictures. They suggested that all of the other style labels were either used synonymously or were sub sets of these two styles. They also included field-dependence/-independence in a comparative review of cognitive styles and found positive correlation between field independence and academic achievement.

In a research study conducted in an alternative school for truancy, Rayner and Riding (1996) noted that the students who were considered to be “wholists” (field-dependent students) displayed behaviors considered likable and pleasant and were
also immature and disruptive because of their lack of natural constraint. On the other hand, the students at the alternative school who were considered to be analytics (field dependent) appeared to be more hostile and physically aggressive with the tendency to bully and be cruel.

Not only do basic differences in the personalities of field-dependent and field-independent individuals exist, but there are also differences in how they process information. Field-independent subjects tend to be better at analytical activities. They can solve complex problems, recall information, isolate facts and separate the relevant from the irrelevant, perceive an item as discrete from its background, impose structure when it is lacking from content, can generally encode information quickly and accurately, and do well on standardized tests. Field-independent learners set goals for themselves, rely on intrinsic reinforcement, and are likely to devise their own strategies for learning (Raynor & Riding, 1997; Richardson & Turner, 2000; Rickards et al., 1997; Riding et al., 1997; Tinajero & Paramo, 1998).

Individual differences are becoming a focus of current instructional designs and practices. Learners are differentially prepared to learn depending on the task and the style of the learner. Matching cognitive style to teaching environments seems to be important because of their potential to enhance learning (Summerville, 1999).

1.5 REVIEW OF THE LITERATURE

Studies related to the research problem reviewed for this investigation are described below.

1.5.1 Related Studies on Multimedia Presentation

In a study, Brusic (1991) examined gains in science achievement for fifth-grade students when technology activities were integrated with traditional science instruction. No statistical difference in achievement gain was found between the two groups, but the treatment group exhibited greater curiosity regarding the
content than the control group did. Brusic noted that incorporation of technology activities might bring potential benefits in increasing students' level of engagement without sacrificing achievement gains.

Lynch (1993) concluded that integrated media instruction being more flexible and versatile upgrade of traditional audio-visual media could also be used by student groups for collaborative learning as well as by individual students for independent learning.

In a meta-analysis carried out by Khalili and Shashaani (1994), 36 independent studies on the effectiveness of computer applications on academic achievement from elementary school to college were utilized. The results showed that the use of computers as instructional tools had a positive effect on learning and achievement across different grade levels. These results were confirmed by Liao (1998) who conducted another meta-analysis that compared the effects of hypermedia and traditional classroom instruction on students' achievement. This study also analyzed 36 independent studies that were published from 1986 to 1997. The results indicating that hypermedia instruction had a moderately positive effect on students' achievement over traditional instruction.

Peck and Dorricott (1994) supported the use of technology in education by concluding that when educators allow students to interact with technologies in meaningful ways for significant periods of time, the growth that follows will encourage educators to try new things. Bozeman & Baumbach (1995) found that schools that had embraced technological change in instructional delivery had seen dramatic improvement consistent with school restructuring.

The study conducted by Peterson and Orde (1995) revealed that students were often bored with material that was too slowly paced, too text-oriented, or written above or below the students' intellectual and/or maturity levels. However, students working with hands-on interaction with sound files, clip art, and videodiscs or CD-ROMs were interested and eager to share their new discoveries with others.
In a study conducted by Williamson and Abraham (1995), it was found that using animations in a chemistry course, where students had difficulty with mental models about the particulate nature of matter, students obtained significantly higher test scores when the animation was viewed as part of a lecture or as a supplement to individual study compared with a control group of students who did not have access to the animation.

Moore and Miller (1996) determined how the use of multimedia affected student learning, class attendance, and retention of information. The sample studied included several sections of the same introductory biology course for non-majors from the University of Cincinnati. They found that the use of multimedia increased class attendance and enhanced retention. In addition, there was a significant improvement in students' grades. Along with student learning, professors' methods of instruction improved, seemed to be more effective, and they were able to cover more material. However, their study also pointed out a couple of disadvantages of the multimedia-based instruction i.e., the cost of equipment and time required to plan lessons to include the multimedia technology.

Rahman et al. (1996) discussed the advantages, requirements and the limiting factors to be considered for creation of multimedia applications in education. They illustrated that adopting multimedia technology in education has made it possible to achieve effective teaching and training in multiple domains which was not possible in the traditional text based environment. Incorporating multimedia technology in a dynamic system with good quality materials for students to access, it is now possible to develop effective new teaching and learning strategies. The optimal use of multimedia technology in education and its full potential will only be realized if it is to be adopted not only as a vehicle for knowledge "delivery", but most importantly as an instructional tool.

A study by Cohen and Holzman-Benshalom (1997) looked at the teaching and learning advantages of multimedia computer projects. The results of their study, however, showed that both teachers and students found using the computer software complicated and confusing, although both groups had received previous
computer training. Other technical mishaps occurred throughout the study, such as deletion of files and introduction of viruses into the systems; all of these problems combined tended to distress the students as well as hinder their motivation to explore.

In a research study performed on the students of technical graphics (design/drafting), Mackenzie and Jansen (1998) examined the effectiveness of Multimedia Computer-Based-Instruction (MCBI) through quantitative analysis and explored student attitudes toward using MCBI in the classroom. The MCBI treatment consisted of 2-D and 3-D images, animations, and audio elements that were all integrated into a highly interactive presentation using an authoring software program. In contrast, the traditional instruction treatment consisted of black and white still-image transparencies and selected physical models. The results of this study indicated that MCBI held promise for improving teaching of technical graphics. The significantly higher scores of the treatment group, coupled with the positive findings on the attitudinal questionnaire supported the use of MCBI-2 over the traditional techniques presently used.

Havice (1998) conducted a study on 367 students to examine the effectiveness of two instructional methods (i.e., integrated media presentations and traditional instruction) on the measure of student achievement while teaching ‘Introduction to Computer Information Systems’. The result indicated that students instructed in a traditional manner showed a higher achievement gain between the pretest and the posttest scores. The researcher suggested that sophisticated technology requires smaller class sizes in order to facilitate the integrated media-supported presentation. He recognized confounding variables such as lack of sufficient lighting that could have possibly affected the quality of the mediated approach.

Lee (1999) while conducting a meta-analysis of 19 studies evaluating the use of educational simulations found that hybrid simulations (those mixing traditional expository presentation with simulations) were much more effective than pure simulations, and that these hybrid uses of simulations were equally effective for
presentation and the practice modes of use. The analysis also found that specific
guidance in simulations seems to help students to perform better.

Carter (1999) stated that multimedia technology is able to offer quickly accessible
information that can interest students of all learning abilities and techniques.
Building on the idea of thematic unit implementation into classroom curriculum,
multimedia offers teachers access to various forms of not only teaching material,
but interactive educational material for their students as well. Students can interact
with the various forms of multimedia in order to properly structure their schemata
of conceptual knowledge, allowing them to become better learners as well as
problem-solvers. He emphasized that the most important aspect of integrating
multimedia successfully into a content area seems to be not what type of
technology is utilized, but how the teacher incorporates its use into the overall
design of a thematic unit.

In his study, Mantei (2000) found that when he incorporated PowerPoint with
sound effects into his lectures and provided class notes on the Internet grades
improved significantly. In addition, he reported that students preferred PowerPoint
lectures over the traditional methods.

A number of studies have suggested that student satisfaction and motivation is
higher in courses that use multimedia materials (Astleitner & Wiesner, 2004;
Yarbrough, 2001). In one particularly large study, Shuell and Farber (2001)
examined the attitudes of over 700 college students toward the use of computer
technology in twenty courses representing a wide range of academic disciplines.
Students were generally very positive about the use of technology, although
females rated the use of technology for learning and classroom instruction
somewhat lower than did their male peers.

Clark et al. (2002) studied the impact of media on learning and concluded that new
media not only enhances motivation but is also useful to solve learning problems.
Results from other studies (Perez-Prado & Thirunarayanan 2002; Cooper 2001;
Smith et al., 2001) also suggest that students can benefit from technology-enhanced collaborative learning methods and the interactive learning process.

Boste et al. (2002) examined the integration of standards-based video clips into lessons developed by classroom teachers and found increased student achievement. The study of more than 1,400 elementary and middle school students in three Virginia school districts showed an average increase in learning for students exposed to the video clip application compared to students who received traditional instruction alone.

Chen and McGrath (2003) investigated how hypermedia design tasks affect student engagement and how creating collaborative hypermedia documents affect students' conceptual learning. The study found a high degree of student attention to organizing information, as well as increased organization and elaboration of concepts in student work.

This study carried out by Macaulay (2003) investigated the effectiveness of multimedia on the learning performance of non-English-speaking third world children. The performance scores of two groups of 18 children were recorded immediately before and after using either multimedia or no multimedia to learn mathematics. The children that used multimedia scored significantly higher than those who did not.

Bartsch and Cobern (2003) investigated whether students liked and learned more from PowerPoint presentations when compared to overhead transparencies and concluded that PowerPoint could be beneficial, but material that was not pertinent to the presentation could be harmful to students' learning.

Jolly (2003) conducted a study to explore the effectiveness of animations-with-text compared to graphics-with-text in comprehending scientific knowledge on fourth, fifth and sixth grade students about the Life Cycle of a Monarch Butterfly. The content of the animation-with-text group was delivered in electronic media in form of animations embedded with text, and the content of the graphics-with-text group was delivered in paper-based format in the form of graphics-with-text. The results
revealed that though there was significantly different in the measure of pre-treatment knowledge level to post-treatment knowledge level in both groups, there were no significant learning gains in the animation-with-text group as compared with the graphics-with-text group.

Conclusions drawn by Stith (2004), who reviewed this issue with a focus on cell biology teaching animations, were contrary to the one mentioned above. Stith reported an initial study where, after a formal lecture on cell death (apoptosis) illustrated with static graphics, some students were subsequently shown an animation after which all students were tested. The students who viewed the animation scored significantly higher on the test than those who had not viewed the animation.

In their study, Culbertson et al. (2004) examined whether technology education improves students' achievement scores in the five areas of reading, language arts, mathematics, science, and social studies. Based on analysis of the data collected in this study, they concluded that there was no significant difference achievement gain between those students who had participated in a unit of modular technology education and those students who had not. The results of this study did not support the claim that participation in a modular technology course can increase students' achievement.

Lewis et al. (2005) undertook a study to explore whether utilizing technology in an undergraduate classroom would increase student understanding of material, attendance, positive teaching evaluations, and student multimedia self-efficacy. Results indicated a significant difference between a traditional and multimedia class in terms of attendance and teacher evaluations, and no differences with regards to grades or self-efficacy.

Morrison and Lowther (2005) laid emphasis on integrating computers into teaching through the use of an inquiry-based, easy to use model for creating lesson plans as a tool for learning rather than as a delivery mechanism.
Koeber (2005) used a quasi-experiment and follow-up questionnaire to ascertain the effects of PowerPoint multimedia presentations and a Blackboard course website on the course grades and perceptions of teaching effectiveness of introductory sociology students. Results of t-tests showed no statistically significant difference in course grades between experimental and control groups. However, students' responses to standardized teaching evaluations were considerably more favorable in the experimental group. Students not only reacted positively to the instructor's use of technology but through their own use of the technology, increased their involvement in the course and came to perceive its teaching more favorably. A study conducted by Zubas et al. (2006) revealed that students completing a web-based tutorial on diabetes mellitus as a supplement to classroom lecture displayed greater improvement in pre- vs. post-test scores compared with students who attended lecture only. Students completing the tutorial indicated a favorable attitude toward computer supplemented instruction.

McClean et al. (2005) did a comprehensive study in which small groups of students viewed a three-dimensional animation of protein synthesis in various combinations of individual study and a formal lecture versus individual study followed by a lecture without the animation. In all cases, the groups viewing the animation scored significantly higher in the follow-up test than the group that did not view it. O'Day (2006) revealed that students understood a complex signal transduction pathway better after viewing a narrated animation compared with a graphic with an equivalent legend. O'Day (2007) undertook another study on the effectiveness of animation versus graphics in the long-term retention of information. The results indicated that animation leads to greater long-term memory retention than simple graphics. On the basis of these studies, it can be concluded that animation provides students with insight into biological processes in a way that traditional lecturing and static graphics do not.

Gili et al. (2008) conducted a study to determine whether the use of computer animation and illustration activities in high school can contribute to student achievement in molecular genetics. Three comparable groups of eleventh- and
twelfth-grade students participated: the control group (116 students) was taught in the traditional lecture format, whereas the experimental groups received instructions that integrated a computer animation (61 students) or illustration (71 students) activities. It was found that students who participated in the experimental groups improved their knowledge in molecular genetics compared with the control group. The open-ended questions revealed that the computer animation activity was significantly more effective than the illustration activity. Based on these findings, use of computer animations in molecular genetics, especially when teaching about dynamic processes was suggested as it improves their achievement in comparison to traditional instruction.

Stephenson et al. (2008) studied the efficacy and popularity of "Virtual Lectures" (text-based, structured electronic courseware with information presented in manageable "chunks", interaction and multimedia) and "e-Lectures" (on-screen synchrony of PowerPoint slides and recorded voice) as alternatives to traditional lectures. Fifty-eight students in three groups took three topics of a human genetics module, one in each delivery style. Results indicated no overall greater efficacy of either delivery style when all question types were taken into account but significantly different delivery-specific results depending on which level of Bloom's taxonomy was assessed. That is, overall, questions assessing knowledge consistently achieved the highest marks followed by analysis, comprehension, evaluation and application. Students receiving traditional lectures scored significantly lower marks for comprehension questions. Students receiving Virtual Lectures scored high for knowledge, comprehension and application but significantly lower for analysis and evaluation questions. The e-Lectures scored high for knowledge questions and were the median for all question types except application.

Muller et al. (2008) conducted a study to empirically verify the coherence principle which states that all non-essential information in multimedia messages should be eliminated to minimize demands on cognitive resources. In this study, 104 students from year 10, year 11, and first-year in university viewed either a
conce or an extended online multimedia treatment on stellar spectra. The extended treatment included additional interesting information about the formation of black holes, galaxy collisions and the observation of dark matter. Following the multimedia, participants completed a retention and transfer test that covered only the material common to both treatments. Results showed students in both treatment groups achieved similar performance. This suggests that in authentic learning settings, interest may mitigate the effects of the coherence principle.

1.5.2 Related Studies on Computer Assisted Instruction

Research studies focusing on student’s attitudes toward computers and computer-assisted instruction have found that individuals have a favorable attitude toward computers. These studies indicated that computers increased creativity and motivation (Kulik et al., 1980; Clement, 1981; Lawton & Gerschner, 1982). Malone (1982) emphasized that computer-assisted-instruction not only increases motivation by providing a context for the learner that is challenging but also stimulates curiosity.

A review of the research concerning the effect of computers on students’ attitudes conducted by Roblyer et al. (1988) concluded that attitudes toward school and subject matter are most affected by computer use. Computer use appears to have a positive impact on improving students’ self-image and self-confidence. After having carried out their independent studies, Keller and Suzuki, (1988); Kinzie, (1990) arrived at the same conclusion that activities that are intrinsically motivating also carry other significant advantages such as personal satisfaction, challenge, relevance, and promotion of a positive perspective on lifelong learning.

Studies by Wilson (1988), showed that thoughtfully designed computer software can present multiple, dynamically linked representation in ways that are impossible with static, inert media such as books and chalkboards. Some of the most fruitful applications of computer technology derive its capacity to present educationally powerful, dynamic visual images particularly in science and math.
Different representation of a complex idea (for example, a concept such as heat), emphasize different aspect of the idea and afford different sorts of analysis.

Hounshell and Stanford (1989) investigated the effectiveness of computer simulations to increase student academic achievement and positive attitude toward science using microcomputers to expand, enrich and supplement the laboratory and lecture components of a traditional biology course. Students in the experimental group who used the computer an average of 60% of the class time during experiments dealing with topics such as genetics, population studies, ecology, and environmental studies scored significantly higher (0.05 level) on both the academic achievement test and on the instruments employed to measure attitude toward science.

Morrell (1992) studied the effect of computer-assisted instruction on student achievement in high school biology. No significant difference was found between the achievement levels of the CAI groups and the control groups. However, the attitude of the CAI group during the photosynthesis unit was found to be positive, but during the genetics unit, attitudes were negative. This could be because the material in the genetics unit was more complicated and the CAI classes had very little teacher assistance.

Rachal (1993) reviewed the experimental literature between the period of 1984-1992, on the effectiveness of Computer-Assisted Instruction in adult basic and secondary education. All reviewed studies utilized control (non-CAI) and experimental (CAI) groups, and most examined any differences in reading, math, and/or other areas of achievement for statistical significance. A few investigations examined attitudes towards computers as well as achievement gains. Of 12 studies meeting the criteria for review, six indicated no statistically significant differences in achievement, two had mixed results, one had significance favorable to CAI, one had significance favorable to traditional methods, and two failed to report statistical significance.
In 1594, Kulik aggregated findings from over 500 individual studies of computer-based instruction. These studies showed percentile gains on achievement tests of 9 to 22 percent over control groups. On average, students who used computer-based instruction scored at the 64th percentile compared to students without computers who scored at the 50th percentile. Kulik also found that computer-based instruction decreases the amount of time required for students to learn basic skills.

In their study, Yalcinalp et al. (1995) compared the use of CAI with problem solving recitations for the instructing of mole concepts. Their study indicated that the use of a carefully prepared CAI software package that incorporated the latest research findings on CAI resulted in greater student learning when compared to a normal teacher-led problem solving recitation.

Tessler et al (1995) stated emphatically that computer-assisted instruction is an effective method for teaching visually oriented subjects such as ultrasonography.

Gokhale (1996) studied the effectiveness of computer simulation for enhancing higher order thinking and concluded that the students who used the computer simulation software in lecture-lab activities performed better on problems than students who were taught traditional lecture-lab instruction. These findings lead the researchers to believe that problem-oriented simulations help develop higher-order thinking strategies and student cognitive abilities.

Research studies that focused on technology and students’ motivation to learn relied on self-reports of students’ attitudes toward computers and found, in general, that most students considered computer activities to be highly motivating and interesting (Gregoire et al., 1996; Heidmann et al., 1996; Kendall & Broihier, 1992).

Computerized learning environments offer several facilities that can be used to improve the teaching of biological processes. A computer enables repeated trials of an experiment with considerable ease in a limited time, provides immediate feedback, allows simultaneous observation of graphical representations and offers
a flexible environment that enables students to proceed with their own plans (Fisher, 1997; Mintz, 1993; Plomp & Voogt, 1995).

Koedinger et al. (1997) suggested that CBI, CAI and ILS (Integrated Learning Systems) could improve student’s basic skills in such disciplines as mathematics.

In Indiana, students participating in the Buddy project were supplied with home computers and modem access at school. Coley (1997) found that project students showed improvement in all writing skills, better understanding and broader view of mathematics, more confidence with computer skills, an ability to teach others, greater problem-solving skills, and greater self-confidence and self-esteem than non-project peers. He also concluded that technology has been found to improve school attendance, decrease dropout rates, and have a positive impact on students’ independence and the realization of responsibility for their own learning.

On the basis of a study of the Apple Classrooms of Tomorrow Project, Sandholtz et al. (1997) found technology to have an enduring and positive impact on student engagement, particularly when technology integrated into other aspects of the students’ education experience.

In a meta-analytic review summarizing the research findings on computer-assisted instruction, Kadiyala and Crynes (1998) concluded that research strongly supports the use of technology as a catalyst for improving the learning environment by stimulating more interactive teaching, more effective grouping of students and more cooperative learning.

Wenglinsky (1998), in his study focused on the relationship between technology characteristics and educational outcomes. Academic achievement in mathematics and the social environment of the school were found to be positively related to teacher’s professional development in technology and the use of computers to teach higher-order thinking skills. The above findings are supported by many other research studies that indicated that computer technology can help support learning and is especially useful in developing the higher-order skills of critical thinking, analysis, and scientific inquiry "by engaging students in authentic,
complex tasks within collaborative learning contexts” (Means et. al., 1993; Roschelle et al., 2000).

Erdner et al. (1998) examined the effects of computer-assisted instruction (CAI) on the reading skills of first graders during the course of a complete academic year and found that extended use of CAI appears to significantly influence the development of reading skills in first graders (approximately 10 percent of variation in pre-post test change). They further reported that students with the lowest scores made the greatest advances, making up an average deficit of 60 points.

Kosakowski (1998) summarizes the observed benefits of CAI, which are: the effective use of educational technology for drill and practice of basic skills (Kulik, 1994), that students learn more, and more rapidly in CAI courses, that the complex multimedia technologies available give learners more control over the learning process, that students feel more successful, are more motivated to learn and have increased self-confidence and self-esteem (Bialo & Sivin-Kachala, 1996), and that teachers and administrators can use computers and information technologies to improve their roles in the education process.

Many studies that have been implemented about the influences of computer-based instructions on students’ attitudes do not agree whether it makes positive changes in attitudes towards science and science lessons (Mitra, 1998). Shaw and Marlow (1999) also suggested that computer-assisted material do not show a positive effect on students’ attitudes.

In contrast to this, Selwyn (1999) reported that computer-assisted material develops a positive attitude towards science education. Brophy (1999) also found computer-assisted instruction to be an effective strategy for teaching science.

Penuel and Means (1999); Silverstein et al. (2000); Statham and Torell (1999); Trilling and Hood (1999) came to the same conclusion that the more advanced uses of technology support the constructivist view of learning in which the teacher is a facilitator of learning rather than the classroom’s only source of knowledge.
Sivin-Kachala and Bialo (2000) reported that technology has been found to have a positive effect on student attitudes toward learning, self-confidence and self-esteem. Silverstein et al. (2000) supported that when technology is integrated into larger instructional frameworks, students will not only learn how to use the equipment and software, but will also gain content knowledge.

According to Hayes and Robinson (2000), computer-assisted instruction is an approach to complement and supplement traditional methods of teaching. It is not intended to supplant or replace teachers and instructors but to serve as a tool to actively engage and stimulate students by enhancing the learning process.

Moreno et al. (2001) conducted two sets of experiments where college students and grade 7 students were engaged in a computer-based multimedia lesson in plant biology with or without the assistance of an animated pedagogical agent which provided verbal advice and encouraging comments. Students working with an agent significantly outperformed peers working without one on problem-solving and rated the program as significantly more interesting.

Several studies have attempted to quantify the effectiveness of computer-assisted instruction. In a meta-analysis that included 42 studies from 1990 onward, Blok et al. (2002) examined the effectiveness of computer-assisted instruction (CAI) programs in supporting beginning readers. The overall effect size was found to be 0.19 which indicated that computer-assisted instruction programs had small positive effect in supporting beginning readers. Their findings were similar to earlier meta-analyses of computer-assisted instruction across both elementary and secondary grade levels conducted by Kulik and Kulik (1991) who found an effect size of 0.30 in support of CAI. Ouyang (1993) also found CAI to have positive but small effects.

On the basis of their review of the efficacy of CAI, Jenks & Springer (2002) stated that understanding the effects of this instruction on learning is important to any future implementations of computers for instruction. The review on computer-assisted instruction (CAI) addresses three major issues concerning its efficacy:
(a) an aging body of literature; (b) the greater effectiveness of using CAI as a supplement to conventional instruction; and (c) the alleged superiority of CAI over conventional instruction. The authors conclude that, due to potential shortcomings in some past research comparing CAI to conventional instruction, CAI should be considered at least as effective as conventional instruction. Next, they conclude that new studies are needed to clarify the effects of CAI in contemporary student/computer environments. Finally, they conclude that how CAI is delivered can influence its effectiveness.

Lowther et al. (2003) examined the educational impacts of providing 5th, 6th and 7th grade students with 24-hour access to laptop computers. Writing assessment results showed substantial and significant advantages for Laptop over Control students. Results also showed significant advantages for the Laptop group on five of the seven components of the problem-solving task.

After examining relationship between computer use and students’ science achievement based on data from a standardized assessment, Papanastasiou et al. (2003) concluded that it is not the computer use itself that has a positive or negative effect on achievement of students, but the way in which computers are used.

Kulik (2003) conducted a meta-analysis of 46 controlled studies of computer-assisted instruction over the past 10 years and found that the scores of students who were taught through computer-assisted instruction were raised by an average standard deviation of 0.46.

Another meta-analytic study on the effects of computer-assisted instruction was conducted by Christman and Badgett (2003). They found that students who received instruction supplemented by CAI attained higher academic achievement than did 63.31% of those receiving only traditional instruction.

Powell et al. (2003) studied the effects of computer-based instruction as compared to instruction without the computer-based instruction on the achievement of subjects that were characterized as disruptive by their school. The results indicated
an improvement in subjects’ academic achievement who were taught by computer-based instruction.

In a case study, Crews (2003) investigated the effectiveness of a CAI reading tutorial in helping poor readers improve their ability to read. The multimedia CAI programme supported the active cognitive participation of the learner, delivered multi sensory instruction, provided timely, directed feedback, taught phonics skills and implemented 100 percent mastery learning. The instruction was individualized and self-paced. Results of pre-post reading comprehension tests and interviews indicated that poor readers completing the CAI tutorial significantly improved their reading skills and the students and their teachers felt that using the CAI tutorial helped the students become better readers.

Qayumi (2004) compared the effects of computer-assisted, text-based and computer-and-text learning conditions on the performances of three groups of medical students in the pre-clinical years of their programme, taking into account their academic achievement to date. A fourth group of students served as a control (no-study) group. Compared to the control group, all 3 study groups exhibited significant gains in performance on knowledge and performance measures. For the knowledge measure, the gains of the computer-assisted and computer-assisted plus text-based learning groups were significantly greater than the gains of the text-based learning group. Analyses of gains by performance level revealed that high achieving students' learning was independent of study method. Lower achieving students performed better after using computer-based learning methods. The results suggested that computer-assisted learning methods will be of greater help to students who do not find the traditional methods effective.

Tabassum (2004) studied the effect of computer-assisted instruction as a supplementing strategy on the academic achievement of ninth grade science students studying biology as elective subject. The results revealed that the students taught through computer-assisted instruction as supplementary strategy performed significantly better than the control group which was kept busy in other activities such as guided practice and independent practice. The students with high
achievement level showed better results than those with low achievement level when taught through computer-assisted instruction. The computer-assisted instruction was found equally effective for both male and female students.

Ranade (2004) listed findings of the meta-analysis of nearly dozen researches carried out by her students since 1999, on the efficacy of CAI in terms of student achievement, interest and reactions. Students were given rating scales or rubrics to rate the usefulness of various features included in the presentation. Most students reacted very positively to these features. The response of students to CAI was found to be overwhelmingly positive. It led to greater inter-student interactions. Results revealed that CAI had in every case led to increased achievement. While visually enhanced and non-enhanced presentations were found to be equally effective in bringing about learning, the former led to better long-term retention. Differences were observed in the way girls viewed the presentations as compared to boys. Girls were far more systemic, followed a linear mode of viewing and took much longer to view the presentations. Teachers who saw the presentations were keen on using them in their classrooms. In view of the above findings, Ranade (2004) concluded that thoughtfully designed CAI is indeed effective in bringing about learning, but when the teacher is really good, a few students prefer traditional face-to-face teaching to CAI. The packages when used in the self-learning/group learning mode can be a better alternative to bad teaching, but can never replace good teachers. They can only enhance their effectiveness. These packages can be best used as visual aids to supplement classroom teaching (shown on a large T.V. or as LCD display).

Mahmood (2004) examined the effect of computer assisted instruction on student achievement in general science as compared to traditional method of instruction. The result revealed that the experimental group outperformed the control group in all achievement areas. Students liked the CAI program and benefited from it. They found it better mode of instruction than the traditional method.

The results of the research study conducted by Ash (2005) indicated that the use of computer-assisted instruction in addition to traditional teaching methods is more
effective than traditional teaching methods alone. No difference was found between the genders of the subjects in the change of their academic achievement as measured by the difference from the pre-test to the post-test.

Karper et al. (2005) examined the effects of computer assisted instruction on academic achievement of 138 graduate students enrolled in a beginning level counselor education course. The results of this study indicated that learning in a computer-assisted instruction environment takes place more effectively than in a non computer-assisted instruction environment.

Trushell and Maitland (2005) studied the effect of digital storybooks on comprehension and recall of grade 4 and 5 students. One group read the storybooks with a choice of paths through the text and access to cued animations and sound effects. A second group read without access to cued animations and sound effects as the computer narrated the story. The results suggested that students with access to cued animations and sound effects demonstrated poorer story grammar recall and inferential comprehension.

Mautone et al. (2005) examined the effects of computer-assisted instruction (CAI) on the mathematics performance and classroom behavior of three second-through fourth-grade students with ADHD (Attention Deficit Hyperactivity Disorder). Their study revealed that participants’ mathematics achievement improved and their on-task behavior increased during the CAI sessions relative to independent seatwork conditions. In addition, students and teachers considered CAI to be an acceptable intervention for some students with ADHD who were having difficulty with mathematics.

Ford et al. (2005) conducted a research study to determine the effect of computer-assisted instruction (CAI), live demonstration (LD) and independent textbook instruction (TXT) on acquisition and retention of knowledge and skills related to musculoskeletal special tests. CAI was found to be as effective as live demonstration and more effective than textbook instruction, particularly in facilitating psychomotor skill acquisition and retention.
Through a quasi-experimental design Basturk, (2005) compared learning outcomes of participants in an introductory statistics course that integrated CAI to participants in a ‘Lecture-only introductory statistics course’. Findings suggest participants’ learning capacity of the introductory statistics could be improved successfully when CAI is used as a supplement to regular lecture in teaching introductory statistics course.

The results of this study conducted by Siskos et al. (2005) suggested that the use of ‘Multimedia Computer-Assisted Instruction’ can be beneficial in the implementation of health-related physical education curricula, particularly in teaching concepts and principles of academic nature.

Vernadakis et al. (2005) undertook a research study to determine if computer assisted instruction (CAI) was a useful tool to enhance cognitive, emotional, linguistic, and literacy skills in preschool children. They concluded that CAI programmes may never replace the book and the blackboard but they were more accessible by young children, who learnt better with pictures and sounds, and the proper use of appropriate programmes could make a considerable difference.

Morgil et al. (2005) compared the traditional and the computer-assisted teaching methods for teaching a fundamental topic of chemistry education, acids and bases. They also investigated the influences of the three dimensional spatial visualization abilities, computational attitudes and learning styles of the students on their acquirement of knowledge which were not found to influence their test scores. However, a 52% improvement was observed in the post-instruction test results of the students of the experimental group whereas the control group only improved by 31% showing a significant difference favoring the experimental group.

Varank (2006) reported that there was no significant difference between computer-based instruction group students’ and lecture-based instruction group students’ total attitudes scores. However, a significant instructional mode effect on students’ motivation was detected in his study.
On the basis of the results of various studies conducted on A First Year Biology Teaching Development Group (FYBT) which was set up in 1993 at School of Biological Sciences, University of Sydney, Peat (2006) concluded that students' perceptions of the use of computer assisted learning in biology were very encouraging, with students rating the modules highly and believing that this type of presentation increased their understanding of the topics. The students perceived that visualization and animations of the processes associated with the modules made the topics considerably easier to understand and they wanted more of this type of learning.

Abdulrasool and Mishra (2006) undertook a case study to understand the effect of computer assisted teaching methodology on learning effectiveness in a laboratory environment. The results indicated that computer assisted instructions helped students achieve learning outcomes at all levels of cognitive domains. A correlation was seen between the pre test ability of students and the levels of cognition most affected. High pre test ability students gained both in high and low levels of cognition where as low ability students gained primarily in low levels of cognition namely knowledge acquisition and routine application.

Akpiner (2006) compared the effects of computer assisted teaching with the traditional way of teaching and found that the means of attitude of students towards science and computer of experimental group were found to be relatively higher than those of the control group. Students found computer-assisted instruction interesting. Additionally, learning preference questionnaire signified that there had been change in some of students’ learning preference. The findings obtained in this study revealed that the interactive software that includes teaching abstract concepts and phenomena is very effective on students’ achievement. The results are endorsed by Hayes (2007) who stated computers and technology are becoming an integral part of today’s classrooms. The use of and increasing growth of technology in the classroom provides new opportunities for delivering instruction.
Sharma (2006) studied the effectiveness of computer assisted instruction (CAI) and self learning modules (SLM) on achievement in economics as related to cognitive style at the secondary stage and found CAI as a superior teaching strategy over SLM strategy. Cognitive Style was found to significantly affect the achievement of students. However the interaction between teaching strategies and cognitive style did not come out to be significant.

Pabla (2006) studied the effectiveness of CAI, VAI and SLM on achievement in mathematics in relation to cognitive style and found CAI and VAI as superior teaching strategies over Self Learning Modules strategy. Cognitive Style acted as a redundant factor. Gender did not account for differential achievement in mathematics. None of the interactional effects were found to be significant.

Kochhar (2007) studied the effectiveness of computer-assisted instruction (CAI) and concept mapping (CM) in acquisition of biological concepts in relation to style of learning and thinking and found CAI and CM as superior teaching strategies over self learning modules (SLM) strategy. Style of learning and thinking proved as a redundant factor. However the interaction between instructional strategies and style of learning and thinking was found to be significant.

Kara and Yesilyurt (2007) investigated the effects of tutorial and edutainment software programs related to “genetic concepts” topic on student achievements, misconceptions and attitudes. An experimental research design including the genetic concepts achievement test (GAT), the genetic concept test (GCT) and biology attitude scale (BAS) were applied at the beginning and at the end of the research. After the treatment, general achievement in GAT increased in favor of experimental groups. It was also noticed that using edutainment software programs significantly changed students’ attitudes towards biology. However, only tutorial design software program had the positive effect to the awareness of students’ understandings to the concepts gene, DNA, nucleus, chromosome, allele, genetic information, and genetic code.
Liao et al. (2007) performed a meta-analysis to synthesize existing research comparing the effects of computer applications (i.e., computer-assisted instruction, computer simulations, and Web-based learning) versus traditional instruction on elementary school students’ achievement in Taiwan. Forty-eight studies were located from four sources, and their quantitative data were transformed into Effect Size (ES). The overall grand mean of the study-weighted ES for all 48 studies was 0.449. The results suggest that computer application instruction is more effective than traditional instruction for elementary school students in Taiwan. However, none of the 14 individual variables, conjectured to be related to achievement, had a statistically significant impact on the mean ES.

Gangwar (2008) studied the effectiveness of computer assisted instruction (CAI) and self learning modules (SLM) on achievement of students in electrical machines in relation to their cognitive style and found both CAI and SLM as equally good strategies as far as achievement of students in electrical machines was concerned. Cognitive Style acted as a redundant factor.

Ragasa (2008) conducted a study to compare the effect of teaching basic statistics with computer-assisted instruction and the traditional method on the achievement and attitude of sophomore college students. It was found that the combination of computer-assisted instruction and collaborated work improved learning without a significant effect on attitude.

Nashef (2008) studied the effect of teaching a biology unit through CAI on achievement of students. The control group was taught through ordinary method whereas the experimental group was taught by distance learning through specially designed CAI. The results showed that the students taught through ordinary method achieved significantly higher than those taught through CAI.

1.5.3 Related Studies on MMP, CAI, Cognitive Style & Gender

Witkin and Moore (1974) found no significant differences in grade point average between field dependent and field independent college students, but there were differences in the types of courses the students selected to take. The field-
independent students took more science and mathematics courses while field-dependent students chose more courses from the social sciences and humanities.

In a research study, Gregorc and Ward (1977) showed strong correlations between cognitive style and preferred learning style (media). Concrete/sequential learners chose ditto sheets, workbooks, CAI, etc. Those with abstract/random dispositions preferred TV, movies, or group discussion; abstract/sequential learners preferred lectures, audio tapes, and reading assignments; and concrete/random preferred games, simulations, and independent study.

Vaidya and Chansky (1980) found that field independence was correlated with higher mathematics achievement, especially for concepts and application.

According to Witkin and Goodenough (1981), people are termed field independent (FI) if they are able to abstract an element from its context, or background field. In that case, they tend to be more analytic and approach problems in a more analytical way. Field dependent (FD) people, on the other hand, are more likely to be better at recalling social information such as conversation and relationships. They approach problems in a more global way by perceiving the total picture in a given context.

The results of the study conducted by Phifer (1983) indicated that field independents recalled significantly more from mathematical/scientific passages whereas field dependents recalled more from socially oriented passages.

Erickson and Erickson (1984) reported that boys do better than girls in the physical sciences, and the gender differences are not substantial in other subject areas including biological science.

Valentine (1990) made a comparative study of Asian and American students using a computer assisted instruction (CAI) supplement to a college-level introductory foreign language course after exploring: (1) Student Background and Characteristics, (2) Cognitive Style, (3) Course Achievement, (4) Time on task, and (5) Student Attitudes. Cognitive Style was measured using Witkin's model of
Field Independence/Field Dependence (FI/FD). The Asian students were found to be more FD than the American students. Time spent in the computer program correlated positively to FD; most affective scales correlated positively to FI. Students leaving the course with more positive feelings toward CAI were those who (1) used the computer more, (2) had higher GPA's, and (3) had lower levels of stress. The Asian students spent significantly more time with the computer than the Americans, even though they had far less access to computing equipment. Computer time was related to the student's prior experience and personal interest in the course material.

In relation to the cognitive effects of computer based instruction (CBI), Liao (1992) conducted a meta-analysis, which synthesized existing research concerning the effects of computer-assisted instruction (CAI) on cognitive outcomes. Research demonstrated that CAI programs contained the following characteristics: provide alternative learning paths for individuals and allow individuals to work at their own pace; they also provide subjects controlled, contingent reinforcement; and they evaluate performance quickly and accurately to provide individuals data on the degree of mastery. It was evident that students were indeed, able to acquire cognitive skills, such as reasoning skills, logical thinking and planning skills and problem-solving skills through CAI. Thirty-one studies indicated that CAI had moderately positive effects on student cognitive outcomes.

Abouserie and Moss (1992) investigated 143 undergraduate freshman students’ attitudes toward computer-assisted learning (CAL) and examined the relationship between students’ attitude toward using CAL and their cognitive style (field dependent and field independent FD/FI) as they relate to gender. A significant correlation was found between students’ attitudes and their field dependency. FD students relied more on CAL than FI students did. The findings also showed that male students preferred using CAL more than female students did.

Wey and Waughn (1993) investigated 61 undergraduate students who were allocated to either a text-only based instruction or a text-with-graphics Results showed that in the text-only group, FI learners performed better than FD learners,
although no differences were observed with the text with graphics treatment FD learners benefit more from materials containing both text and graphics.

Wang and Jonassen (1993) conducted a study of students using a hypertext program to learn transfusion medicine. The findings showed that FI students were more actively engaged than FD students. FI students also covered most of the course, spent more time in evaluation, and appeared to read more.

Liu and Reed (1994) examined cognitive style and media selection in educational hypermedia programs. They used a hypermedia program to teach English to international students in which learners could choose different presentation formats for supporting information about vocabulary words they were instructed to learn. They found that field dependents utilized the video vignettes more often than field independents, who preferred text-based presentations. Although the navigation and information presentation selections differed, field dependents and field independents did equally well on the post test.

Frey and Simonson (1994) who used a hypermedia lesson to examine the choice of media by home economics and education undergraduates in a hypermedia lesson on historic costume reported similar results. They examined nine learning styles from the National Association of Secondary School Principals Learning Style Profile (NASPLSP) as learner variables. They found statistically significant correlations between media choice and analytical ability and spatial skill. As with the study by Liu and Reed, there were no significant interactions between cognitive styles, media choices, and performance on a posttest.

Weller et al. (1994) studied the effect of hypermedia software on 33 eighth-grade students enrolled in computer literacy courses. It was found that FI learners learned more effectively than FD students did. The authors reported that the two groups appeared to differ in the way they accessed information. FI learners displayed stronger information-seeking behavior than FD learners. Learning style interacts with outcomes and approaches to learning.
A number of authors supported the above findings that educational software can accommodate the differences in cognitive styles. (Chinien & Boutin, 1992/1993; Chou & Lin, 1998; Liu & Reed, 1994; Whyte et al., 1996), others claim the contrary (Burger, 1985; Post 1987; Rowland & Stuessy, 1988).

Some researchers claim that no correlation exists between attitudes toward computers and cognitive styles (see, Hart, 1995). In a research study, Jones (1994) explored the existence of such a relationship with 140 undergraduate and graduate students by using the Myers-Briggs Type Indicator (MBTI). A small but insignificant correlation between the variables was found.

The Third International Mathematics and Science Survey (TIMSS, 1994-1995) shows that boys do better than girls in math and science generally. But in certain areas of the two disciplines, such as life science, or certain types of mathematical problems, girls perform better than boys. The difference depends much on students' familiarity and interest in the subjects, and the context in which the problems are set.

Esiobu & Soyibo (1995) studied gender differences in relation to cognitive achievement using two teaching strategies (Concept and Vee Mappings) to teach Ecology and Genetics. Though the post-test means scores of boys were consistently slightly higher than those of girls in all groups, there were no statistically significant gender differences in achievement.

Lu and Suen (1995) recruited 102 undergraduate students enrolled in an introductory educational psychology class for their study. Students were given six take-home assignments, considered to be performance-based, and four multiple-choice tests. The relationship between the first two take-home activities, the multiple-choice tests, and the cognitive styles of the participants was analyzed. The cognitive styles of the students were measured using the Group Embedded Figure Test. A substantial interaction between cognitive style and assessment approach was found in this study. Field-independent students scored substantially
higher on performance-based assessment than did field-dependent students, whereas no such difference was found on the multiple-choice test.

Lin and Davidson-Shivers (1996) examined the effect of a hypertext linking structure on comprehension and attitudes of 139 undergraduate students. FI students performed better and showed more positive attitudes towards the hypermedia materials than their FD counterparts. Motivation to learn interacts with learning styles.

Daniels (1996) examined the relationship between the cognitive style field dependence/independence (FI/FD) and learner control of presentation mode in a hypermedia environment. This experiment revealed no causal relationship between field dependency and the provision of control over presentation mode in hypermedia environments, nor a predictive relationship between field dependency and selection of presentation mode. Field dependents in the treatment and control groups performed equally on tests of recall and problem-solving. Daniels summarized the general tendencies of field dependent and independent learners as follows:

Field-dependents:

- Rely on the surrounding perceptual field.
- Have difficulty attending to, extracting, and using non-salient cues.
- Have difficulty providing structure to ambiguous information.
- Have difficulty restructuring new information and forging links with prior knowledge.
- Have difficulty retrieving information from long-term memory.

Field-independents:

- Perceive objects as separate from the field.
- Can disembed relevant items from non-relevant items within the field.
- Provide structure when it is not inherent in the presented information.
- Reorganize information to provide a context for prior knowledge.
- Tend to be more efficient at retrieving items from memory.
Leader and Klein (1996) tested four different database search tools with undergraduate students undertaking hypermedia database searches. FI learners did better with those tools that encouraged exploration while FD did better with more directed tasks. Search strategies interact with learning styles.

In another study, Murphy et al. (1997) sought to determine the relationship between academic achievement and cognitive style of 63 undergraduate Canadian students in information management program. They found that field independent students performed better than field dependent subjects only on one of the technical courses. For the other three courses, the two groups performed similarly.

Tinajero and Paramo (1997) investigated the relationship between cognitive styles and student achievement in several subject domains (English, mathematics, natural science, social science, Spanish, and Galician). With the sample of 408 middle school students, the researchers asserted that cognitive style was a significant source of variation in overall performance of students. That is, field independent subjects outperformed their field dependent counterparts.

Fitzgerald and Semrau (1998) studied the effect of FI/FD learning styles on usage patterns and learning outcomes of twenty-three pre-service teachers engaging with hypermedia case studies. Although there were some differences in the usage pattern of the hypermedia instructional components, these differences did not have an effect on learning outcomes. Hypermedia environments do not favour any particular learning style.

Huppert et al. (1998) studied the effect of teaching Microbiology with computer simulations on students’ academic achievement in relation to gender. The results indicated that students in the experimental group achieved significantly higher means scores than the control group. No significant gender differences on academic achievement were found within each group.

Ching-Chun Shih and Gamon (1999) investigated 99 university students who chose to take two courses Zoology and Biology. Most of the materials and resources for this course were accessed and delivered through the Internet.

More FI
learners chose to take the courses than FD learners; however, there was no difference between FI and FD students in their motivation, learning strategies and achievement in web-based courses. Web-based instruction appears to be more appealing to FI learners.

Yea-Ru Chuang (1999) examined the combined effect of three media factors (text, voice and computer animation) on 175 Taiwan seventh grade children’s mathematics achievement in relation to learning style and gender. Results indicated that subjects performed significantly better on the posttest in the animation+text+voice version, which was also the favorite interface design chosen by most of the subjects. It was also found that the animation+text+voice interface effect was only strong for FI subjects, males, or students with low math achievement.

Summerville (1999) studied the effect of a hypermedia environment on 177 students enrolled in undergraduate technology courses and found no significant differences in achievement and satisfaction scores of FD and FI learners. However, interviews revealed that FD learners preferred more step-by-step instructions with more human direction thus concluding that FD learners need more social interaction and assistance in a hypermedia environment.

Chanlin (1999) studied gender differences in learning using different presentation formats (Animation, Still-graphics, Text) with three hundred and fifty seven eighth and ninth-grade student participants. It was found that the gender effect was significant in procedural learning but not in descriptive learning. Boys performed better than girls in procedural learning. The treatment effect was significant among girls, and insignificant among boys in both descriptive and procedural learning.

Xiding and Grimley (1999) explored the effects of gender differences along with cognitive style in student learning via multimedia and traditional materials and concluded that in both gender groups irrespective of their cognitive style, performance was best with presentations that combined picture, text, and sound.
In a study undertaken by Dimitrov (1999) to determine patterns of gender differences in science achievement of fifth graders, the results indicated that there were no gender differences in life science achievement.

Ray et al. (1999) compared the attitudes of men and women toward computer technology and concluded that women are in fact more comfortable with computers than men. Similarly, young people are also thought to be more versed in using computers. Butler (2000) reported that males generally have a more positive attitude toward computers, the primary medium for digital images, than females.

Research on university biology students by Bahar and Hansell (2000) indicated that field-independent subjects have a higher working memory capacity than those who are field-dependent. They also found that field-independent students could more readily sort “signal” (relevant) information from “noise” (incidental) information.

The findings from the data analysis of the research study conducted by Passerini, (2000) indicated that the effectiveness of technology-based learning is dependent upon the nature of the presented topic. In-class instruction is more suitable for high-complexity topics, while those studying lower-complexity topics benefit from self-paced learning using interactive multimedia software. In terms of learning objectives, student recall performance is higher than application performance in a short-module of instruction. Positive attitudes toward interactive multimedia and textbooks are higher than in-class instruction when the latter uses an average speaker to deliver a soft topic. Attitudes toward in-class instruction are higher when the speaker is an above average presenter or when the topic of instruction is highly complex.

Coley (2001) studied gender differences in elementary and secondary education within racial and ethnic groups by administering various tests of the National Assessment of Educational Progress (NAEP) to a nationally representative sample of students at three grade or age levels. The lack of conclusive findings about a
gender gap in achievement, as measured by standardized tests, suggested that there was no systematic disenfranchisement of male and female students, although traditional gender differences in both course selection and subject-specific achievement persist. Gender differences in science achievement between boys and girls were found to be minimal.

Vichitvejpaisal et al. (2001) compared text-based instruction to computer-based instruction and found that students who learn from text-based materials take relatively less time to read and understand the material; however, they seem to lose their perceived recall quicker than those who learned from the computer-based materials. From these observations, it was also noted that instructional software promoted good educational content, quality imagery, interactive questions and problems, and ease of use along with the ability to move around in the program. With CBI, students are being able to recall information quicker and also learn from authentic learning that is found in the software design.

Based on the results of a study carried out by Luk (2002) on the relationship between field dependence and academic learning in context of distance learning, it was concluded that Field independent students perform better academically than those who are field dependent, and this is particularly marked in distance learning where students learn without the traditional support offered in conventional instruction.

Altun (2003) who investigated the relationship between attitudes toward computers and cognitive styles by using Group Embedded Figures Test with 67 undergraduate university students found small but not significant correlations between these variables.

Sungur and Tekkaya (2003) conducted a study on 10th-grade students to investigate the effect of gender and reasoning ability on the human circulatory system concepts achievement and attitude toward biology. The results revealed that although there was no statistically significant mean difference between boys and girls with respect to achievement and attitude toward biology, there was
statistically significant mean difference between concrete and formal students with respect to achievement and attitude toward biology.

In their study, Njagi et al. (2003) found that both males and females had reasonably good attitudes to computer technology, generally males were found to have a better attitude.

Alomyan and Au (2004) conducted a research study with undergraduate university students to investigate the effect of students’ cognitive styles, achievement motivation, prior knowledge, and attitudes on achievement in a web based environment. In their findings, they have found no differences between students’ attitudes toward web based learning and their field dependencies.

Almekhlafi (2006) investigated the effect of interactive multimedia (IMM) program on students' acquisition of some English as a second language (ESL) skill. Participants were classified according to their cognitive styles into field-dependent (FD) and field-independent (FI) learners using Witkin's test. No significant difference was found between IMM users and non-users in the overall ESL skills. However, when the participants were investigated in terms of their cognitive learning styles, results showed a significant difference between field dependent learners and field independent learners in the experimental group in favor of field-independent learners.

Altun and Cakan (2006) carried out a study to find if there were any correlations in cognitive styles, achievement scores and attitudes toward computers among university students. Overall, it was found that there was no significant relationship between cognitive styles and academic achievement; cognitive styles and attitudes toward computers; and, cognitive styles and attitudes toward computers when their academic achievement scores were covaried. The findings indicate that students’ attitudes toward computers are not associated with field dependency, even when their achievement levels were controlled. No significant relationship was observed between males and females.
Becker (2006) used two meta-analysis methodologies to study the magnitude of gender differences in science achievement. Analyses revealed that magnitudes of gender differences in science achievement varied according to the subject matter under study. Males showed significant advantages in studies of biology, general science, and physics, but significant differences were not found for studies of mixed science content, and geology and earth sciences, or in a single study of chemistry.

Maghsudi (2007) reported mixed evidence on the effect of gender on field dependence-independence. No gender differences were found in the results of studies conducted for children. However, in studies of adults when differences between gender and field dependence-independence were found, males always achieved scores that were indicative of greater field independence. The effect of gender on field dependence-independence was found to be so small that this factor was practically insignificant.

Wong & Hanafi, (2007) conducted a quantitative study on gender differences in attitudes toward the usage of Information Technology (IT) related tools and applications. The attitudes of the respondents (73 female and 29 male student teachers) were measured in terms of three dimensions, namely, usefulness, confidence and aversion. No significant differences were found between female and male student teachers when the pre- and post-test mean scores were compared. Both genders exhibited the same levels of attitudes before and after undergoing the comprehensive IT course, suggesting that the exposure to IT did not contribute to any significant gender disparity.

The integrated science achievement of graduating pre-service teachers from a college of education in Nigeria over a period of three years was examined for gender differences by Afuwape and Oludipe (2008). Findings revealed that there was no gender gap in achievement between males and females.
1.5.4 Summary of Reviewed Literature

The major findings that have emerged on reviewing the cited research studies regarding MMP and CAI, and their interaction with Cognitive Style and Gender are summarized below.

Most of the reviewed studies showed favorable results for the effectiveness of various types of multimedia presentations in teaching of diverse subjects over traditional classroom instruction resulting in higher achievement scores. Student satisfaction and motivation has also been found to be higher in courses that use multimedia materials (Astleitner & Wiesner, 2004; Bockholt et al., 2003; Boster et al., 2002; Brusic, 1991; Clark et al., 2002; Cooper, 2001; Culbertson et al., 2004; Gili et al., 2008; Kadiyala & Crynes, 1998; Khalili & Shashaani, 1994; Koeber, 2005; Lee, 1999; Liao, 1998; Macaulay, 2003; Mantei, 2000; McLean et al., 2005; Moore & Miller, 1996; O’Day, 2006, 2007; Perez-Prado & Thirunarayanan, 2002; Peterson & Orde, 1995; Rahman et al., 1996; Shuell & Farber, 2001; Smith et al., 2001; Stephenson et al., 2008; Stith, 2004; Williamson & Abraham, 1995; Yarbrough, 2001; Zubas et al., 2006). However, very few contrary findings mentioned that students instructed in a traditional manner showed a higher achievement gain than the ones taught through multimedia presentations (Havice, 1998; Jolly, 2003). Some studies pointed out a couple of disadvantages of the multimedia-based instruction i.e., the high cost of equipment and more time required to plan lessons to include the multimedia technology (Moore & Miller, 1996), finding the use of computer software complicated and confusing, technical mishaps occurring throughout the study, such as deletion of files and introduction of viruses into the systems; all of these problems combined, tended to distress the students as well as hinder their motivation to explore (Cohen & Holzman-Benshalom, 1997).

Computer-assisted instruction (CAI) produce higher achievement scores as students learn material faster and retain what they have learned better with this strategy than with conventional instruction. This holds good even for challenged and disruptive students (Ford et al., 2005; Gangwar, 2008; Hounshell & Stanford,
The use of CAI also leads to more positive attitudes toward computers, course content, quality of instruction, school in general, and self-as-learner than the use of conventional instruction (Akpiner, 2006; Clement, 1981; Fisher, 1997; Hayes & Robinson, 2000; Kara & Yesilyurt, 2007; Kulik et al, 1980; Lawton & Gerschner, 1982; Mintz, 1993; Mitra, 1998; Morrel, 1992; Plomp & Voogt, 1995; Roblyer et al., 1988; Sivin-Kachala & Bialo, 2000; Wenglinsky, 1998). The use of CAI is associated with other beneficial outcomes, including greater internal locus of control, higher-order thinking skills, school attendance, motivation/time-on-task, and student-student cooperation and collaboration (Coley, 1997; Gokhale, 1996; Gregoire et al., 1996; Heidmann et al., 1996; Keller & Suzuki, 1988; Kendall & Broihier, 1992; Kinzie, 1990; Malone, 1982; Means et al, 1993; Roschelle et al, 2000). CAI is more beneficial for younger students than older ones and with lower-achieving students than with higher-achieving ones and for teaching lower-cognitive material than higher-cognitive material (Abdulrasool & Mishra, 2006; Crew, 2003; Erdner et al., 1998; Passei, 2000; Bayumi, 2004; Trushell & Maitland, 2005; Vernadakis et al., 2005; Yeang, 1999). Some studies point out that the use of CAI as a supplement to conventional instruction produces higher achievement than the use of conventional instruction alone (Ash, 2005; Basturk, 2005; Christman & Badgett, 2003; Tabassum, 2004). A few alternate studies do not agree whether it makes positive changes in attitudes towards science and science lessons (Mitra, 1998; Shaw & Marlow, 1999; Varank, 2006). Many studies have revealed that effects of CAI are positive but small (Blok et al., 2002; Kulik & Kulik, 1991; Ouyang 1993). Nashef (2008) found that students taught through ordinary method achieved significantly more than those taught through CAI.

Some studies have indicated that there were significant interactions between cognitive styles, media choices, and academic performance (Chinien & Boutin, 1992/1993; Chou & Lin, 1998; Frey & Simonson, 1994; Gregore & Ward, 1977;

Many studies point out that FI students performed better and showed more positive attitudes towards the hypermedia materials than their FD counterparts (Almekhlafi, 2006; Ching-Chun Shih & Gamon, 1999; Lin & Davidson-Shivers, 1996; Luk, 2002; Weller et al., 1994; Yea-Ru Chuang, 1999). A few studies indicate that FD students rely more on CAL than FI students do (Abouserie & Moss, 1992; Butler, 2000). Others found that Hypermedia environments do not favor any particular learning style and both FI and FD students groups performed equally on tests of recall and problem-solving (Daniels, 1996; Fitzgerald & Semrau, 1998).

Male students have been reported to prefer using CAL more than female students do (Abouserie & Moss, 1992; Njagi et al., 2003) whereas, there are studies that find women more comfortable with computers than men (Ray et al., 1999). Both males and females had reasonably good attitudes to computer technology, (Altun, & Cakan, 2006; Wong & Hanafi, 2007). Both boys and girls are found to be equal with respect to achievement and attitude toward biology and integrated science (Afuwape & Oludipe, 2008; Sungur & Tekkaya, 2003). Multimedia effect is only strong for FI subjects, males, or students with low math achievement (Yea-Ru Chuang, 1999).

It will be worthwhile to describe the insights derived from the studies reviewed:

- Thoughtfully designed MMP and CAI software package that incorporates the latest research findings along with efficient delivery of the content are indeed effective in bringing about learning (Carter, 1999; Wilson, 1988; Morrison et al., 2005; Tessler et al., 1995; Yalcinalp et al., 1995). Material that is not pertinent to the presentation could be harmful to students' learning (Bartsch & Cobern, 2003). All non-essential information in
multimedia messages should be eliminated to minimize demands on cognitive resources (Muller et al., 2008).

- Computer-assisted instruction is an approach to complement and supplement traditional methods of teaching. It is not intended to supplant or replace teachers and instructors but to serve as a tool to actively engage and stimulate students by enhancing the learning process (Jenks & Springer, 2002; Hayes & Robinson, 2000; Papanastasiou et al., 2003; Ranade, 2004; Ash, 2005).

- The studies about the interaction among teaching strategies, cognitive style and gender are found to be inconclusive, hence need to be studied further.

1.6 EMERGENCE OF THE PROBLEM

The innovation in instructional technology has offered new possibilities for imparting quality education. Adopting multimedia technology in education has made it possible to achieve effective teaching and training in multiple domains which was not possible in the traditional text based environment (Rahman et al., 1996). A broad range of studies seem to confirm that the use of technology as a learning tool can make a measurable difference in student achievement, attitudes, and interaction with teachers and other students. One of the most powerful uses of technology in education such as computer-assisted instructions is to tailor instruction to students’ individual learning needs as it enables students to learn at their own pace. Research studies also indicate that when students interact with the computers they become inquisitive and creative with an increase in their level of intrinsic motivation because of acquisition of the freedom to take over their own learning (Armour-Thomas, 1992; Ganguli, 1992; Gatto, 1993, Lehman, 1994; Moar & Fraser, 1994; Wang & Sleemen, 1994).

Multimedia can incorporate 3-D visualization of many biological and biochemical structures as well as more interactive animations of the processes, which can
substantially enhance the understanding of learners of biological concepts (Bockholt et al., 2003; Mackenzie & Jensen, 1998; Stith, 2004).

Multimedia technology can maximize the potential of the learner’s intelligences and improve their quality of learning, e.g. hands-on interactivity enhances the kinesthetic intelligence; logical/mathematical intelligences can be maximized through problem solving. Irrespective of one’s intelligence level, multimedia presentations trigger visualization strategies such as mental imagery, which is crucial to many kinds of problem solving and improves retention (Dervan et al., 2006).

Multimedia is becoming an important tool for faculty in the biological sciences due to increasing conceptual and functional complexity that presents educational challenges that cannot be adequately addressed with traditional teaching methods (Buckley et al., 1999). Teachers need to modify their teaching strategies to accommodate the unique features offered by the new technology and provide learners with opportunities to access knowledge experts as well as their peers. Such a learning teaching-environment could lead to the achievement of the major objective of the shift in education, that is, to empower the learners to become more independent in the learning process so that they would develop the attitude and skills for lifelong learning (Lourdusamy et al., 2001).

Because multimedia technology exists in such a diverse, array of interactive and stimulating material, its integration into biology curriculum offers a wide variety of learning possibilities for students as well as teachers.

Though a great deal of research has been carried out to find the effectiveness of using different multimedia tools separately, little research has been conducted to study the effectiveness of multimedia presentations and computer assisted instructions together in acquisition of biological concepts. Therefore, chosen research study is considered worthwhile due to its deemed potential to take on the research further in this specific area especially in the Indian context.
1.7 STATEMENT OF THE PROBLEM

EFFECTIVENESS OF MULTIMEDIA PRESENTATIONS AND COMPUTER ASSISTED INSTRUCTION IN ACQUISITION OF BIOLOGICAL CONCEPTS IN RELATION TO COGNITIVE STYLE

1.8 OBJECTIVES OF THE STUDY

The study was undertaken keeping in view the following objectives:

1. To develop multimedia presentations on various biological concepts.
2. To develop a package for computer assisted instruction in biological concepts.
3. To compare the effect of computer assisted instruction with multimedia presentations in acquisition of biological concepts.
4. To compare the effect of computer assisted instruction with lecture method in acquisition of biological concepts.
5. To compare the effects of multimedia presentation and lecture method in acquisition of biological concepts.
6. To study whether gender accounts for differential achievement in acquisition of biological concepts.
7. To study the effect of cognitive style on achievement.
8. To study whether there is a significant interaction among gender, cognitive style and different instructional strategies.
9. To evaluate students’ attitude regarding multimedia presentations and computer assisted instruction in acquisition of biological concepts.

1.9 HYPOTHESES

The study was conducted to test the following hypotheses:

1. There will be a significant difference between mean achievement scores of students exposed through various instructional strategies:
   1) Computer assisted instruction and multimedia presentations
   2) Multimedia presentations and lecture method
   3) Computer assisted instruction and lecture method
2. Gender does not account for differential achievement in learning of biological concepts, irrespective of instructional strategies.


4. There will be no significant interaction between instructional strategies and gender.

5. There will be no significant interaction between instructional strategies and cognitive style.

6. There will be no significant interaction between gender and cognitive style in acquisition of biological concepts.

7. There will be no significant interaction among instructional strategies, cognitive style and gender in acquisition of biological concepts.

8. There will be a significant difference in the attitude of students towards various instructional strategies viz. computer assisted instruction, multimedia presentations and lecture method.

1.10 DELIMITATION

1. The present study was delimited to 180 class IX science students of CBSE affiliated English medium schools of Chandigarh.

2. The study was also delimited to selected topics of biology included in the CBSE syllabus of class IX.

3. The study was confined to two variables i.e., gender and cognitive style.