CHAPTER I
INTRODUCTION

1.0 INTRODUCTION

Education is an engine for the growth and progress of any society. It not only imparts knowledge, skills and inculcates values, but is also responsible for building human capital, which breeds, drives and sets technological innovation and economic growth. Education is also a general concept that includes methods of teaching. A method of teaching is a process that involves the procedures undertaken by the teacher to achieve certain various objectives for the students. There are multiple ways to deliver information in classroom settings: lecturing, direct instruction, textbook recitation, cooperative learning, discussion method, problem-based learning, and discovery method to mention a few (Moore, 2009).

Modern age is the age of science and technology. As the world is becoming more and more civilized, brutal animal energy is receding into background, giving place to science, which is increasingly felt as a powerful force in the lives of human beings. On one hand, it has empowered the values, attitudes and conventions, trying to modify, change, alter or replace those, which are traditional and old. One the other hand, it has supported the pedagogical practices in the classroom situations.

Research findings reveal that with the proper use of science and technology in the field of education, desirable results can be achieved in teaching, learning and teaching processes. The answer to the ever-increasing demand and problems related to present challenges of education (acc. to UNESCO) lies in the integration of multimedia technology. Therefore, there is a shift from traditional method of teaching to modern methods of teaching.

Educational technologies have had a long history of use, going back to the fifteenth century with the introduction of movable type, to the use of illustrations in books in the seventeenth century, to using slate chalkboards in the eighteenth century (Jonassen et. al, 1999). These technologies were, at that time, considered new in the classrooms as they sought to enhance the teaching and learning process,
which were simply the teacher talking and the students listening. Traditional face-to-face teaching (Instructor-led Era) was introduced for more than 3000 years ago and is still a dominant form of knowledge transfer. Adapting a technology based approach in teaching and learning has started since 1960s.

The notion of using technology for educational purposes is not new. In fact, it can be traced back to the early 1900s during which school museums were used to distribute portable exhibits. This was the beginning of the visual education movement that persisted throughout the 1930s, as advances in technology such as radio and sound motion pictures continued. The training needs of World War II stimulated serious growth in the audiovisual instruction movement. Instructional television arrived in the 1950s but had little impact, due mainly to the expense of installing and maintaining systems. The advent of computers in the 1950s laid the foundation for CAI (computer assisted instruction) through the 1960s and 1970s. However, it wasn’t until the 1980s that computers began to make a major impact on education (Reiser, 2001). In the 1960s and 1970s, the first technology-based training approach came with minicomputer and had benefitted hundreds to thousands of people (Bersin, 2004). In the early 1980s, the arrival of the first personal computer (PC) rushed educators and trainers into PC multimedia technologies (Bersin, 2004). Between 1984-1993, we entered a new era, the multimedia era (Bersin, 2004).

Thus, the present study has been carried out by the investigator to compare the effectiveness of the multimedia approach and the traditional method of teaching.

1.1 TRADITIONAL TEACHING METHOD

In the traditional method of teaching, the teacher is the sender or the source, the educational material is the information or message and the student is the receiver of the information. In terms of the delivery medium, the educator can deliver the message via the “chalk-and-talk” method and overhead projector (OHP) transparencies. This directed instruction model has its foundations embedded in the behavioral learning perspective (Skinner, 1938) and a popular technique, which has been used for decades as an educational strategy in all institutions of learning. In this model, the sender is represented by the teacher or the educator, the information or message is represented by the educational content being delivered, and the receiver
of the information is represented by the student via a delivery medium (Figure 1.1).

**Figure 1.1 The Traditional Instructional Communication Process (ICP)**

The teacher controls the instructional process, the content is delivered to the entire class and the teacher tends to emphasize factual knowledge. Thus, the learning mode tends to be passive and the learners play little part in their learning process (Orlich et al., 1998). It has been found in most universities that the conventional lecture approach in classroom is of limited effectiveness in both teaching and learning. In such a lecture students assume a purely passive role and their concentration fades off after 15-20 minutes. Some of the following limitations highlighted below may prevail in traditional teaching method:

1. Teaching in classroom using chalk and talk is “one way flow” of information.
2. Teachers often continuously talk for an hour without knowing students response and feedback.
3. The material presented is only based on lecturer notes and textbooks.
4. Teaching and learning are concentrated on “plug and play” method rather than practical aspects.
5. The handwriting of the lecturer decides the fate of the subject.
6. There is insufficient interaction with students in classroom.
7. More emphasis has been given on theory without any practical and real life time situations.
8. Learning is from memorization but not understanding.

As the world hurtles towards the 21st Century, it is necessary that educators should pause to evaluate the development of new technologies like interactive multimedia and understand its impact on education. Learners benefit from
multimedia because they can now enjoy learning intuitively, independently or socially. Proper integration and use of interactive multimedia in education can help smooth the path to instructional enlightenment because it can, among other things, provide effective communication, clarify concepts and enhance teaching and learning via the natural multisensory and intuitive approach. Therefore, our task as instructors and trainers is to sort, absorb, understand and utilize these new technologies to optimize teaching, training and learning.

1.2 TYPES OF MEDIA

1. Multimedia: Multimedia is the combined use of text, graphics, animation, pictures, video, and sound to present information in a coherent manner.

2. Monomedia: Monomedia stands for the use of one of the media viz: - text, audio, Video, Graphics and animation for transferring information.

3. Redundant Multimedia: Redundant multimedia refers to the extra channel for transferring information, above and beyond the bare minimum required. For example, to explain the working of a diesel motor, text can be used as a monomedia for explanation. However if audio narration were used together with the text, it would be considered as redundant multimedia.

4. Edutainment: Edutainment refers to the integrated use of several media, such as text, graphics, audio, video, and animation for the combined purpose of education and entertainment. Edutainment represents the use of multimedia computing as the bridging gap between the Educational and Entertainment Industries.

1.3 ADVENT OF MULTIMEDIA: THE ULTIMATE SOLUTION

With the introduction of multimedia into various industries, many educators began to see computers as part of a combination of technology resources, which included media elements such as text, graphics, sound, video and animations, instructional systems and computer based support systems. Multimedia is the combination of various digital media types such as text, images, sound and video, into an integrated, multi-sensory, interactive application or presentation, to convey a message or information to an audience. In other words, multimedia means "an
individual or a small group using a computer to interact with information that is represented in several media, by repeatedly selecting what to see and hear next" (Agnew, Kellerman & Meyer, 1996).

With computing technology becoming increasingly powerful and easily accessible, the role of computers has changed. Computers are now able to provide students with rich learning experiences and enabling them to have more depth and direction in their learning processes. In terms of functionality, the computer has gone beyond processing only text and data. It can now process various media elements such as high-resolution graphics, animation, sounds and video. And, now, with the addition of multimedia technology, the scope of computers as an instructional medium increases rapidly, with multimedia becoming the medium of instruction and the computers becoming the means with which the multimedia content is created.

By the mid-1990s, the PC had increased enormously its processing power as more and more microprocessors that are powerful became available. Throughout the 1990s, numerous CD-ROM educational multimedia software was produced and was used in educational settings. The PC has become a powerful multimedia PC (MPC), many of the media elements can now be processed on the desktop and multimedia applications can be created with user-friendly software (Figure 1.2).

![Figure 1.2 The Multimedia Personal Computer (MPC)]
1.3.1 WHAT IS MULTIMEDIA?

Bob Goldstein (later Bobb Goldstein’) coined the term “multimedia” in July 1966 on the eve of his, "Light Works at L'Oursin" at Southampton, Long Island. Multimedia (as an adjective) also describes electronic media devices used to store and experience multimedia content.

Multimedia refers to computer-mediated information that is presented concurrently in more than one medium. It consists of some, but not necessarily all, of the following elements: Text; Still Graphic Images; Motion Graphics; Animations; Hypermedia; Photographs; Video; and Audio, i.e., Sounds, Music, and Narration (Kleen & Shell, 1994; Najjar, 1996; Tannenbaum, 1998). Phillip (1997) characterized multimedia by the presence of text, pictures, sound, animation and video; some or all of which are organized into some coherent programme. According to Mayer (1997), multimedia learning occurs when information is presented in more than one mode. Multimedia today refers not only to what is presented through computers, but also through the composition of text and illustrations in print media (Iding, 2000).

The research on Multimedia based educational methodology is often hyped to take over the traditional teaching methods. However, despite Edison's grand prediction in 1922 that "the motion picture is destined to revolutionize our educational system and that in a few years it will supplant...the use of textbooks" (cited in Cuban, 1986, p. 9). The concept of literacy increasingly, is a measure of the ability to read and write. In the modern context, the word means reading and writing at a level adequate for written communication. A more fundamental meaning is now needed to cope with the numerous media in use, perhaps meaning a level that enables one to function successfully at a certain status in society. Multimedia is the use of several different media to convey information. With the widespread use of computers, the basic literacy of ‘reading’ and ‘writing’ are often done via a computer, providing a foundation stone for more advanced levels of multimedia literacy.
1.3.2 INTERACTIVITY: THE HEART OF MULTIMEDIA

Multimedia, is "woven combinations of text, graphic, art, sound, animation, and video elements. When you allow an end user -- the viewer of a multimedia project -- to control what and when the elements are delivered, it is interactive multimedia" (Vaughan, 1998). A key feature in interactivity is that "it empowers the end-users of the application by letting them control the content and flow of information" (Vaughan, 1998).

Interactivity in a multimedia application can be either linear or non-linear. With linear multimedia, there are no interactive features embedded into the design and the user simply navigates through the application in a sequential manner, whereas with non-linear multimedia, interactive features are embedded and the user can navigate to any part of the application in a non-sequential manner. With such interactivity, the audience is involved in the communication process and in the navigation of the content. Research suggests that people remember 20% of what they see, 40% of what they see and hear, and about 75% of what they see, hear and do simultaneously (Lindstrom 1994).

Therefore, interactivity and interactive features in a multimedia application facilitate interaction between the computer and the user (Bates & Poole, 2003).

1.3.3 WHAT IS INTERACTIVE MULTIMEDIA?

Interactive Multimedia: What is “interactive”, “multi” and “media”?

- **Interactive**: Users can use a variety of input devices to interact with the computer, such as a joystick, keyboard, touch screen, mouse, trackball, microphone, etc.

- **Multi** refers to the multiple file usages used in the multimedia product such as sound, animation, graphics, video, and text.

- **Media**: Many media sources can be used as components in the multimedia product, such as a videodisk, CDROM, videotape, scanner, CD or other audio source, camcorder, digital camera, etc.

Hence it is defined as "The term 'interactive multimedia' is a catch-all phrase to describe the new wave of computer software that primarily deals with the
provision of information. The ‘multimedia’ component is characterized by the presence of text, pictures, sound, animation and video; some or all of which are organized into some coherent program. The ‘interactive’ component refers to the process of empowering the user to control the environment usually by a computer’.

If done properly, interactive multimedia excels in leaving lasting impressions in the learning process. Retention rates increase by 25% to 50%.

Examples of environments where interactive multimedia is being used:

- Touch screen kiosks (museums, hospitals, bank lobbies)
- Distance education (via computer, compressed video, satellite...)
- Interactive, educational software on CDROM or videodisk
- Virtual Reality “theatres”.

With interactivity, multimedia presentations created can be highly involving to the students. Interactive features can be easily integrated into the multimedia application by authoring tools (Neo and Neo, 1999), to provide a more engaging experience for the students and increase their learning and retention rates (see Figure 1.3).

![Diagram](http://www.ascilite.org.au/ajet/ajet19/neo.html)
The incorporation of multimedia into the teacher’s instructional process means that there is a union between the educational content and the multimedia technology. This will result in the production of a learning experience that is multi-sensory, visually challenging to the student, and most importantly, interactive.

With multimedia technology being introduced into the classroom environment, there are more options for the delivery of the information. The use of technology and multimedia reinforces the ICP and change the roles of the instructors and students. Now, the teacher becomes the director of the knowledge-access process and will make a difference in the integration of the media into this process.

The modified ICP now involves the selection of the information, the arrangement and the delivery of it in an appropriate environment. This process would also cultivate some interaction between the student and the information itself, making the learning process more effective for the student. The educational content is still the information or message to be delivered by the teacher (the sender) to the student (receiver), but now, the type of instructional media or educational content that the teacher would be using would be computer-based interactive multimedia.

1.3.4 MULTIMEDIA BUILDING BLOCKS

Broadly categorized the various building blocks of the multimedia are as follows:

a. Text

Text for multimedia package can be produced using a number of Word Processing Softwares. Many newer authoring packages also allow most of the Word processing facilities. While developing text for Multimedia application it has to be ensured that the text format, which has to be developed, is compatible to the Authoring tool text format.

b. Graphics

Graphics is the most predominant component of a Multimedia. Graphics may be used in many forms such as photos, Charts for illustration and summarization numerical data, environments simulation, logos, and colours that illustrate the content of the application.


c. **Sound**

In a Multimedia application text, images, animation can be greatly complimented by the use of sound. Sound is an internal part of videos also. Sound helps the users to receive and retain the multimedia message in a better way. Sound may also break the monotony of Multimedia base tutors and enhance the learning process.

d. **Video**

The digital video is represented as a sequence of frames having a rectangular screen with each pixel being represented by 8 bits (black and while video) or 24 bits (coloured video). Digital video can be acquired from either digital recording or by converting analog video footage of high quality into digital video. The most common of those are Quick time, MPG and AVI.

e. **Animation**

Animation is used to show changes in state over time, or to present information slowly to students so they have time to assimilate it in smaller chunks. Animations, when combined with user input, enable students to view different versions of change over time depending on different variables. Simple animations add enjoyment to the electronic brochure and attract the attention of browsers to the display at trade show booth or store front. However, more complex animation can be used to demonstrate and instruct. With animation, man can show the operation of product in ways that are impossible with static pictures.

1.3.5 **MULTIMEDIA AUTHORING**

Once all the components of Multimedia are introduced, one has to know the importance of using authoring tool to stitch the multimedia building blocks, which also involves interactivity.

There are four basic function provided by almost all authoring software:

- **Creating:** It should allow some basic features for creation of text, graphics and may be sound if not video.

- **Importing:** It should be able to import various media elements, which may have been developed using other software package.
• **Integrating:** It should allow you to define sequences and provide linkages

• **Delivering:** It should allow developing self-running application and encryption of application data.

1.4 **MULTIMEDIA AND ICT REVOLUTION**

The advent of multimedia and ICT has rapidly altered the scenario in using instructional technologies in the educational institutions particularly in higher education. The current multimedia and ICT (Information and Communication Technology) revolution is fast changing the world, and creating a generation that is media-hungry and technologically perceptive. This new generation is using digital media for learning and communication (Tapscott, 1998). Information and Communication Technologies have enabled the convergence of a wide array of technology based and technology mediated resources for teaching learning. It has therefore become possible to employ ICT based multimedia tools as an omnibus support system for education. The potential of ICT mediated technologies to respond to the various challenges the Indian education system poses are:

1. These can be beneficially leveraged to disseminate information about and catalyze adaptation, adoption, translation and distribution of sparse educational resources distributed across various media and forms. This will help promote its widespread availability and extensive use.

2. There is an urgent need to digitize and make available educational audio and video resources, which exist in different languages, media standards and formats.

3. Given the scarcity of print resources as well as web content in Indian languages, ICT and multimedia technologies can be very gainfully employed for digitizing and disseminating existing print resources like books, documents, handouts, charts and posters, which have been used extensively in the school system, in order to enhance its reach and use.

4. The advanced technologies can address teacher capacity building, ongoing teacher support and strengthen the school system's ability to manage and improve efficiencies, which have been difficult to address so far due to the size of the school system and the limited reach of conventional methods of training and support.
5. Using computers and the Internet as mere information delivery devices grossly underutilizes its power and capabilities. There is an urgent need to develop and deploy a large variety of applications, software tools, media and interactive devices in order to promote creative, aesthetic, analytical and problem solving abilities and sensitivities in students and teachers.

1.5 MULTIMEDIA AND LEARNING

Davis explains three ways multimedia can support our learning methods (Davis 1996).

- At a basic level it helps users recognize words, terms and their meaning.
- At the next level visual perception presents information in different ways using shapes, graphics, colour, and movement.
- Then interactive learning can be achieved via role-playing and situation games or communication with other users over the Internet.
- Figure 1.4 is a graph that shows how much we retain through different modes of learning.

![The Modes Of Learning](http://www.willatworklearning.com/images/chigra1.gif)

**Figure 1.4: The Graph showing how much we retain through different modes of learning.**

(Source: http://www.willatworklearning.com/images/chigra1.gif)

Multimedia learning can be defined in a number of ways. Today’s K-12 students are very different from even their recently graduated peers. These students are **digital natives**, a term attributed to futurist Marc Prensky to distinguish between those who have grown up with technology and those who have adapted to it. They live in a world in which digital technology is part of the texture of their daily lives.
They have never known a world without technology. Technology is their —native language and they expect to use technology in school. While some students have greater access to technology than others, computers with Internet access are now and should be the part and parcel of all Indian schools. Internet-enabled computers and cell phones are omnipresent outside of school. Use of technology by 5-18 year olds is at its highest level and is projected to increase. This increased reliance on technology combined with what we know about brain processing, offers enormous potential for instruction. Research has shown us that the brain processes information using two channels—visual and auditory. When information is presented using both channels, the brain can accommodate more new information.

![Diagram of the Structure and Process of Learning from Multimedia](http://www.itdl.org/Journal/Oct_06/images/Fig%25201-1.gif)

By taking advantage of this multimodal processing capability and technology-based tools, we can dramatically enhance student learning through multimedia instruction.

### 1.5.1 COGNITIVE THEORY OF MULTIMEDIA LEARNING

Cognitive theory of multimedia learning is one introduced by an American psychology professor Richard Mayer in the 1990s. This theory is a sub-theory of John Sweller's cognitive load theory applied especially for multimedia learning, and therefore has many similarities with it. Basic assumption of Mayer's theory is
that the human working memory has two sub-components that work in parallel (visual and verbal/acoustic) and that learning can be more successful if both of these channels are used for information processing at the same time (see Figure-1.6).

![Cognitive theory of multimedia learning](https://i.imgur.com/2.png)

**Figure 1.6**: Showing the Cognitive theory of Multimedia Learning (Source: http://t0.gstatic.com/images)

Mayer’s theory is based on three assumptions suggested by cognitive research:

1. **Dual-channel assumption** - The verbal and visual channels (similar to what Baddeley called phonological loop system and visuospatial sketchpad) in our working memory are separated and can be used for processing information simultaneously thus enhancing process of learning. The suggestion that human working memory has more sub-components firstly came from the working memory models designed by Alan Baddeley and Graham Hitch in 1974 and reviewed by Baddeley in 1992. These findings where further incorporated to the Dual coding theory by Allan Paivio and later by Mayer and his colleagues.

2. **Limited capacity assumption** - As Miller's Information processing theory has shown, these channels have limited capacity and limited time they can hold information. Too much information can therefore cause cognitive overload.

3. **Active-processing assumption** - Learning is an active process of collecting,
organizing and integrating new information. Similarities with constructivist learning may be noticed in this definition.

Together with cognitive load theory, which offers a more detailed description of cognitive load types and possible causes of cognitive overload, the mentioned assumptions of cognitive theory of multimedia learning form a framework and theoretical basis for most contemporary research on learning. This research is mostly oriented on two goals:

- utilizing both information processing channels, and
- managing cognitive load and avoiding cognitive overload.

1.5.2 PRACTICAL MEANING OF COGNITIVE THEORY OF MULTIMEDIA LEARNING

There is a growing body of research exploring what makes multimedia effective. Below, are some of the most important principles of multimedia learning and what the research says about how they contribute to student learning (also see Figure 1.7)

1. **Words and pictures are better than words alone**: The fundamental principle behind multimedia learning is best described by Richard Mayer (2005), one of the leading researchers in this area: —People learn better from words and pictures than from words alone. In this context, words include written and spoken text, and pictures include static graphic images, animation and video. That using both words and pictures is more effective than words alone should not be surprising in light of what we know about how the brain processes information. Research tells us that the use of both words and pictures lets the brain process more information in working memory (Sweller, 2005).

Extending this basic principle, Mayer (2005) and his colleagues tell us that narration and video is much more effective than narration and text. Similarly, narration and video appear to be more effective than narration, video and text. Narration and text rely on the same channel to process information (Baddelley, 1999). It seems that text heavy multimedia presentations may be less effective than those that rely on narration.
Recall that for learning to take place, information from working memory must successfully make its way to long term memory. By using multiple channels of working memory, multimedia content can increase the likelihood that information will be effectively integrated into long term memory and not lost. For example, a narrated animation that balances the presentation of content between the animation and the narration (and keeps the amount of text to a minimum) is more likely to be effective.

2. **Multimedia learning is more effective when learner attention is focused, not split:** Multimedia applications are more effective when learner attention is not split. Split attention occurs when the learner is forced to attend to information that is far apart, such as when content is visually far apart on the screen or if it is presented at two separate points in time. In short, when related content is presented together in time and visually, learning is more effective (Mayer, 2005). Words and pictures presented simultaneously are more effective than when presented sequentially (Mayer and Sims, 1994). For example, narration and animation presented together are more likely to contribute to student learning than the presentation of narration and then animation (or animation and then narration).

Multimedia applications that have text and pictures presented in close proximity (or that may overlap) are more effective than those applications that present text and pictures far apart on the screen. Learners studying integrated information outperform learners studying the same information where attention is split (Chandler and Sweller, 1991).

3. **The presentation of multimedia content should exclude extraneous and redundant information:** Research suggests that multimedia learning is most effective when it includes only content that is relevant and aligned to the instructional objectives (Mayer, 2003). Kalyuga, Chandler and Sweller (1991) found that students learned more when extraneous and redundant information was not included in a multimedia presentation.

Learning is most effective when interesting and irrelevant information is eliminated because of the brain’s limited information processing resources. Multimedia designers and users would do well to resist the temptation to present extraneous information.
4. **Multimedia learning is more effective when it is interactive and under the control of the learner:** Not all students learn at the same pace. Research tells us that when learners are able to control the pace of the presentation they learn more (Mayer, Dow, and Mayer, 2003).

Multimedia presentations are more effective when the learner has the ability to interact with the presentation, by slowing it down or by starting and stopping it. This pacing can also be achieved by breaking the presentation into segments; shorter segments that allow users to select segments at their own pace work better than longer segments that offer less control.

5. **Multimedia learning is more effective when learner knowledge structures are activated prior to exposure to multimedia content:** Learning from multimedia presentations is enhanced when the structures for organizing the information are activated (Pollock, Chandler, and Sweller, 2002). Activation can be accomplished by allowing students to preview the content though demonstrations, discussion, directed recall and written descriptions. These preview activities should be directed at activating prior knowledge (Kalyuga, 2005), signaling what is important, and showing how the content is organized. Reviewing terminology that will be encountered, presentation of graphic organizers, class discussion, and assessments can also be helpful in activating prior knowledge. Activating knowledge helps provide a structure from long-term memory to understand and organize the new information from working memory.

6. **Multimedia instruction that includes animation can improve learning:** Several studies have suggested that learning is enhanced in computer-based animation environments (Park, 1994; Tversky, Bauer-Morrison and Betrancourt, 2002). Animation appears to be most effective when presenting concepts or information that students may have difficulty envisioning (Betrancourt, 2005). It helps the student visualizing a process or other dynamic phenomenon that cannot be envisioned easily. This is especially true for processes that are not inherently visual (e.g., electrical circuits, forces in physics). Animation seems to work better with novices than experts (Mayer and Sims, 1994).

Students who are less familiar with the content in question are likely to benefit more than those who have more familiarity with the content. Animation also
appears to be more effective when students have the ability to start and stop the animation and view it at their own pace or are able to manipulate various facets of the animation. When provided with the ability to interact with the application in this way, students seem to both enjoy the experience more and perform better when tested on the content (Mayer and Chandler (2001).

7. **Multimedia learning is most effective when the learner is engaged with the presentation:** Multimedia is more effective when the content and format actively engage the learner. Active engagement helps the student construct knowledge and organize information into meaningful schema (Mayer, 2003). Multimedia that is more personalized, engages learners more than multimedia that is less personalized (Mayer, 2005a).

Learners tend to find presentations that use a familiar voice with a familiar accent more engaging than those that use a less familiar voice and accent (Mayer, Sobko and Mautone, 2003). And, presentations that use the more familiar “you and I” are more engaging than those that present in the third person (Mayer, 2005a).

The use of onscreen characters can increase student engagement. This is especially true when the onscreen character appears to interact with the learner (Craig, Gholson and Driscoll, 2002). Presenting educational concepts in a “story” format can also be effective in engaging students. The narrative format can engage students and help them learn (Lowe, 2002). Combining onscreen characters and an underlying narrative to present content as a story can be particularly effective.

8. **Multimedia learning is most effective when the learner can apply their newly acquired knowledge and receive feedback:** Multimedia is most likely to be effective when students are provided with opportunities to apply what they have learned following exposure (Mayer, 2005). This reinforces and strengthens the newly acquired knowledge. Students should be provided with opportunities to integrate what they have learned with their everyday life. Other strategies that help students integrate what they have learned include follow-up learning activities, class discussions and group activities.
Multimedia Content Characteristics
1. Words and pictures are better than words alone.
2. Multimedia learning is more effective when learner attention is focused, not split.
3. The presentation of multimedia content should exclude extraneous and redundant information.

Multimedia Delivery Characteristics
1. Multimedia learning is more effective when it is interactive and under the control of the learner.
2. Multimedia leaning is most effective when the learner is engaged with the presentation.

Multimedia Context Characteristics
1. Multimedia learning is more effective when learner knowledge structures are activated prior to exposure to multimedia content.
2. Multimedia learning is most effective when the learner can apply their newly acquired knowledge and receive feedback.

Figure 1.7: Flow Chart Showing the Characteristics of Multimedia with reference to Content, Delivery and Context

Feedback is an important part of the learning process, and multimedia is no exception. It is important to provide learners with clear feedback about their progress on an ongoing basis (Gee, 2005; Perkins, 1992). Feedback helps keep students informed about their progress and helps them stay engaged (Gee, 2005).

Both formal and informal feedback can support learning following multimedia exposure. Formal assessments (tests and quizzes) should be supplemented by in-process monitoring and comments from teachers. Multimedia applications that provide opportunities for student self-assessment offer a particularly valuable opportunity for feedback.

All of these design effects are stronger for low-knowledge learners than for high knowledge learners, and for high-spatial learners rather than for low-spatial
learners. Still, all of the mentioned suggestions for more efficient learning should be implemented with caution, since real-life learning environments are always much more complex than laboratory conditions.

1.6 WHEN IS MULTIMEDIA-BASED EDUCATION USEFUL?

There are three main scenarios when using Multimedia instruction would be appropriate.

1. **When the students have low prior domain knowledge or spatial learning aptitude:** When multimedia is used with students who have low prior domain knowledge or spatial aptitude, the multimedia helps the students in developing mental models and connects to the new knowledge domain. They are better able to visualize the activities in the knowledge domain and learn from them. On the other hand, a student with high prior domain knowledge or high spatial aptitude would be able to create mental models of the knowledge domain without any external help and not gain anything from the use of Multimedia. Thus the cost and the effort in multimedia instruction would go waste.

2. **When students have low motivation:** When dealing with students with low learning motivation, it is very important to keep them interested in learning. Interesting lessons would keep the students interested and enable them to do their own self-directed learning and research (Tan and Leong, 2003). Use of pictures, animations, and sounds can help in keeping the students interested in learning about a new domain. The interactivity generated by the use of multimedia instruction would also help in motivating the students towards learning. On the other hand, highly motivated students might not need these audio-visual aids and be able to understand the instructions given in text format itself.

3. **When effectively designed multimedia content is available:** This is indeed the most difficult aspect to deal with in the use of multimedia-based instruction. Unless we have properly designed multimedia content, there is no point in using it. When defining the appropriate medium to use it is vital to ‘know’ the audience and the technical specification of users’ machines. There may be technical reasons for choosing which multimedia element will best
communicate certain concepts. Whatever medium is chosen, to apply a principle mentioned above to all digital media elements, visuals must be congruent, relevant, and consistent with other information presented in order to be effective. Whatever the latest technological advance, instructional design principles apply. For example, care needs to be taken when using visuals for aesthetic reasons. The misuse of a single visual element can cause misrepresentation of information and become a barrier to content and impede learning, even if the program overall may, in all other aspects, follow the principles of instructional design. It is important to bear in mind the nature of the audience, especially their age group and culture mix.

Employing multimedia tools into the learning environment is a rewarding, but complex and challenging task. All of the multimedia formats available: text, sound, video, animation and graphics, already exist in one form or another in most libraries. Students can explore an almost infinite variety of information. All these explorations can certainly lead to new discoveries, but unless consumption is followed by production, the story ends. Without a chance to use their new discoveries and demonstrate what they have learned, the knowledge gained soon becomes the knowledge forgotten.

1.7 IMPORTANCE OF MULTIMEDIA APPROACH

Today, users require access to or communication of information in the most speedy and efficient manner as possible. With multimedia, navigational and participatory features provide more flexibility and control to the users. These unique features allow them to quickly access information when they need it and how they want it. Giving students an opportunity to produce multimedia documents of their own provides several educational advantages. Students work with the same information from four perspectives: 1) as researcher, they must locate and select the information needed to understand the chosen topic; 2) as authors, they must consider their intended audience and decide what amount of information is needed to give their readers an understanding of the topic; 3) as designers, they must select the appropriate media to share the concepts selected; and 4) as writers, they must find a way to fit the information to the container including the manner of linking the
information for others to retrieve.

The following is a summary of some advantages that can be gained by utilizing multimedia in the modern smart classroom:

1. **Reduced Learning Time:** According to some research, interactive multimedia/videodisc training can reduce training time up to 60% over traditional classroom methods. This can be attributed to the immediate interaction and constant feedback which provides excellent reinforcement of concepts and content. Also, self-paced instruction which allows students to control the pace and content of their learning i.e. more difficult concepts can be repeated or familiar content can be skipped.

2. **Reduced Cost:** The cost of interactive multimedia lie in the design and production. When the same program is used by more students, the cost per student is reduced, unlike the traditional instructional system which needs to cater to teacher salaries and overheads regardless of the number of students.

3. **Instructional Consistency and Fairness:** Instructional quality and quantity are not compromised as technology based interactive instruction is consistent and reliable.

4. **Increased Retention:** The interactive approach provides a strong learning reinforcement and therefore boosts content retention over time.

5. **Mastery of Learning:** A good interactive system can ensure the learning of the prerequisites by learners before proceeding to new content. This provides a strong foundation for continued learning and therefore helps to achieve mastery learning.

6. **Increased Motivation:** Immediate feedback and personal control over the content provided by an interactive multimedia system has proven to be highly motivating to learners.

7. **More Interactive Learning:** Interactive systems enable learners to have more responsibility and better control over their learning and this generates a greater interest to actively seek new knowledge rather than passively accept instruction.
8. **Privacy/ accommodates Individual Learning Styles:** This system allows for one to one learning and caters to the different learning styles of individuals. The freedom to ask questions repeatedly without embarrassment and the involvement of each individual learner motivates them and reduces the potential for distraction.

9. **Flexibility:** The flexibility comes from the ability to navigate, by using a keyboard, mouse or touch screen, through an interactive program and to choose what and how much information we want and when we want it.

10. **Online Availability of Lecture Notes:** Instead of taking notes, the whole class was able to participate in a lively discussion during each lecture. Because of the contents of the web design course, it would be technically not difficult to present pictures and other visual material on the computer.

11. **Access to Additional Course Material on the Internet:** When needed, the instructor had immediate access to numerous online resources that contained relevant information. The students, in turn, realized the immense potential of the Internet as an electronic library.

12. **Hands-on Experience:** Many hours of Internet usage allowed the students to become fully aware of the Internet architecture, and the related topics such as the World Wide Web, the internet protocol, bandwidth and storage requirements, and the server-client relationship.

1.8 **APPLICATIONS OF MULTIMEDIA**

a) **Multimedia Entertainment:** Multimedia made possible innovative and interactive games that greatly enhanced the learning experience. These applications attracted even those to computers, who otherwise would never have used them for any other application. Games and entertainment products may be accessed on standard computer workstations via CDs or networks or on special purpose.

b) **Multimedia Business:** Even basic office applications like a MS word processing package or a MS Excel spreadsheet become a powerful tool with the
aid of multimedia business. Pictures, animation and sound can be added to these applications, emphasizing important points in the documents and other business presentations. Multimedia has been also a favorite area for organizations as a means of training employees. McCrea and others (2000) and Urdan and Weggen (2000).

c) **Video Conferencing and Virtual Reality:** Virtual reality is a truly fascinating multimedia application. In this, the computer creates an artificial environment using hardware and software. It is presented to the user in such a way that it appears and feels real. Three of the five senses are controlled by the computer in virtual reality systems. Another multimedia application is videoconferencing. A video conference is a set of interactive telecommunication technologies which allow two or more locations to interact via two-way video and audio transmissions simultaneously. It is been called visual collaboration and is a type of groupware.

d) **Electronic Encyclopedia:** It is the application of multimedia for the creation of an encyclopedia with millions of entries and hypertext cross references covering a wide variety of research and reference topics mainly for educational and training purposes.

e) **Faculty Development:** In Break-out Session 3 of the NSF workshop (National Science Foundation, 1996), it was observed: The observations and recommendations derived from the NSF workshop included those for faculty development. One observation was that IT increases the variety of needs for training including the use of IT itself, applications, and teaching techniques. In the opinion of the participants, faculty development must be long-lived through communities of support, and innovators must aspire to and be rewarded for, increased efforts for dissemination of effective technology to commercial publishers and through professional societies.

f) **Multimedia for Presentations:** An interactive multimedia presentation provides the possibility of a more personal computing. Given the choice of integrating graphics, audio and video and the cross referencing of spreadsheet figures and charts with voice annotations our presentations become 'sensory rich

Thus, multimedia can be used for education, training, simulations, digital publications, museum exhibits and so much more.

1.9 SIGNIFICANCE OF MULTIMEDIA IN EDUCATION

The interactive multimedia materials that are created can then be delivered to the student via a number of methods. Some of these methods range from demonstrations and presentations, drills and practices, and tutorials, which are more teacher-centered methods of teaching and learning, to cooperative and collaborative learning, problem-solving and Web-based learning, which are more student-centered methods of teaching and learning (Jonassen et. al, 1999).

In the teacher-centered learning methods, the teacher is the one in control of the information that is received by the students and is responsible for how much information is being disseminated to them. With the teacher-centered approach, the students are given the same amount of information at the same time and able to use several senses (e.g., sight, sound and even interactive experiences), as in the case with presentations and demonstrations, to process the information. They are also able to retain and recall the information as well as obtain mastery in the subject matter with drills, practices and tutorials, which are highly interactive. The teacher holds on to the knowledge base and delivers that knowledge base directly to the student as is shown in Fig. 1.8. The use of innovative multimedia practices, however, allows for a change in the role of the teacher in education.

In the student-centered learning methods, the students construct their own knowledge and bring their authentic experiences into the learning process with the teacher as the facilitator. With student-centered approach, the multimedia material can be used to foster team processing and active learning as with collaborative and cooperative methods, encourage higher-level learning skills and increase comprehension and retention rates, as in the case of using problem-solving methodologies.
In the student-centric instructional model, the learners play an active part in their learning and construct their own knowledge or meaning of what they learn. The learners determine how to reach the desired learning outcomes themselves. With this change in role, the teacher becomes a true facilitator, a manager of the learning process rather than the source of all knowledge. The teacher still remains in control but steps to one side to allow the student a more direct access to knowledge (as shown in Fig. 1.9), with the teacher facilitating and organizing the learning process.
This can be achieved because the state of the art of interactive multimedia has opened up new possibilities of knowledge engineering and knowledge linkage. The layers of information can be made intuitively available to the learners, without the learners having to understand the complexity of knowledge engineering and linkages that went behind its creation.

This learning mode is embedded in the Constructivist learning philosophy, which has evolved over the last half of the 20th century and has its foundations in cognitive learning psychology. In this Constructivist model, learners must construct their own meaning of what they learn, and learning builds on what learners have already constructed in other contexts. The teacher, in this case, is no longer perceived as the sole authority of learning, but rather, as the person to facilitate learning, guiding and supporting learners' own construction of knowledge (Jonassen et. al, 1999).

There is another approach to delivering multimedia applications in the educational environment. This approach combines the two previous approaches and posits that the teacher can use a variety of methods in the instructional situation. In fact, the teacher has the flexibility to incorporate the two teaching and learning approaches and use whichever method he or she deems useful to increase and enhance the students learning processes. This new approach seeks to become a hybrid approach to teaching and learning with multimedia technology.

1.10 FUTURE OF MULTIMEDIA

Although some of the ideas that are being explored for the use of multimedia in education today are interesting and good there are plenty of unexploited opportunities that the new technologies could offer. This section looks at Virtual Environments and Simulations, which is an area that if developed well could play an increasingly important role in Education in the future.

1.10.1 Virtual Learning and Virtual Environments (Simulators)

Simulations have started to emerge but are not a widespread technology. “The technique of imitating the behaviour of some situation or process (whether economic, military, mechanical, etc.) by means of a suitably analogous situation or
apparatus, esp. for the purpose of study or personnel training” [Oxford English Dictionary]

Merrill et al. refer to simulations as being "a representation or model of a real or imagined specific object, system or phenomenon” [Merrill et al. 1996]. They can be valuable as they give us the ability to recreate for students a situation or environment that would be otherwise impossible to create.

An example where a virtual environment has been created and used to great benefit today is in the training of pilots. Simulators can be used in a variety of ways to teach a pilot to fly. Economically they can be much cheaper because less time has to be spent in a real aircraft. Then disaster situations, which would otherwise be impossible to create, can be set up. A student could be placed in a simulation where aircrafts systems fail that just wouldn’t be possible in real life.

Some higher education institutes have explored creating virtual environments as a way of students being able to more fully appreciate how the theory they have learned fits in with the practice. There are people who currently say that the way we learn today is outdated and needs a fresh approach.

1.11 NEED AND SIGNIFICANCE OF THE STUDY

The traditional view of the learning process is typically teacher centered, with teachers doing most of the talking and intellectual work, while students are passive receptacles of the information provided. This is not to indicate that the traditional lecture method is without value, as it allows the teachers to quickly convey lot of information to students and is a useful strategy for recall or rote learning. However, it is not the most effective way to help students develop and use higher order cognitive skills to solve complex real world problems.

Today the use of computers and technology in the classroom has greatly increased. An area of education in which the use of technology is becoming more apparent is classroom teaching; therefore, research studies focusing on this area of major importance to the field. Many teachers and other educators are integrating the use of technology into the delivery of instruction, such as distance education (Meloaac & Blocher, 1998), the internet (Gray, 1998; Weins & Gunter, 1998) and

Technology acts as a catalyst to support change in teacher’s pedagogy. With new technologies a teacher is no longer the sole source of knowledge but instead is a guide or facilitator who supports students learning. Students in their new role become empowered as creators of things they could not create before or as researchers with technology providing access to information from all over the world. It introduces students to a real world enquiry approach, rather than relying solely on textbooks and the teachers for information to learn.

Don Tap Scott, in his book “Growing Up Digital : The Rise of the Net Generation”, (1998); notes that we are entering a new era of digital learning in which we are in the process of transitioning from “Broadcast” to “Interactive” learning. Today’s students no longer want to be passive recipients in the information transfer model of learning. Rather they want to be active participants in the learning process.

Students respond to information differently. Thus, it is often to our advantage as teachers to use many formats and modes to teach the subject matter of lesson. This is why teachers normally use some combination of lecture, text and hands-on laboratory for conveying information. With the advent of the Internet and the multiple formats that can be communicated over the World Wide Web, we now have several new and exciting ways to present information. The Web allows the incorporation of animation, moving pictures, and sound into lessons, which extends our abilities to present materials that encourage student’s interaction with the subject matter. Pictures and animations help bring to life scientific principles, and multimedia allows students to take a more active role in learning; they can watch experiments in action, see micro-organisms up close, and use a mouse or Keyboard to navigate images, simulations and interactive material.

Thus, all the above mentioned discussion in relation to the need of the study can be summarized, as that, Multimedia approach makes lesson simple and easy to learn, develops interest among students to their subjects, control and change the behavior, makes teaching more practical, make education process more scientific and interesting and also helps in achieving the objectives of education. Therefore,
using multimedia in the teaching and learning environment enables students to become critical thinkers, problem-solvers, more apt to seek information, and more motivated in their learning processes. Multimedia is slowly gaining ground as a way for students to represent the knowledge that they acquire in class and to construct their own interpretation of the information acquired. It also fosters collaborative and cooperative learning between and among students, thus better preparing them with a skill set for real-life work situations.

In the light of above said role of multimedia approach and its utility in effective classroom teaching; has inspired the investigator to undertake the present study.

1.12 STATEMENT OF THE PROBLEM

“Effect of Multimedia Approach and Traditional Method on Retention and Academic Achievement of Science Students at Secondary School Level – A Comparative Study”

1.13 OPERATIONAL DEFINITION OF THE TERMS USED

1. MULTIMEDIA APPROACH: In the present study the term multimedia approach means the use of different media (i.e. audio, video, audio video, print text, graphics, etc) in combination for the effective teaching and learning.

2. TRADITIONAL METHOD: The term traditional method in the present study means the usually followed conventional method also called the chalk and talk method, lecture method. It is the teacher centered approach.

3. RETENTION: Retention means memorization of the concepts (which will be clearly understood and learnt by the students) for a longer time.

4. ACHIEVEMENT: In the present study achievement means the measuring tool used for ascertaining the quantity of learning attained in the subject after a period of instruction.

5. SCIENCE: The term science in the present study means the subject to be taught, also called as General Science.
6. **SECONDARY:** In the present study the term secondary means post elementary education i.e. from class IX-XII.

### 1.14 OBJECTIVES

1. To develop two multimedia instructional packages as a part of multimedia approach for the teaching of science to the students at secondary school level, in order to:
   
   i. Prepare the multimedia package-I which contains the lessons in the form of computer assisted PowerPoint presentations and a comprehensive booklet.
   
   ii. Prepare the multimedia package-II which contained the lessons in the form of interactive multimedia software, computer assisted PowerPoint presentations and a comprehensive booklet.

2. To compare the relative effect of multimedia approach (multimedia package-I and multimedia package-II) and traditional method on total academic achievement and retention of secondary school science students.

3. To compare the relative effect of multimedia approach (multimedia package-I and multimedia package-II) and traditional method on academic achievement and retention of secondary school science students according to the different instructional objectives.

4. To compare the relative effect of multimedia approach (multimedia package-I and multimedia package-II) and traditional method on academic achievement and retention of secondary school science students at varying levels of intelligence.

5. To study the opinion of students regarding learning through multimedia approach.

### 1.15 HYPOTHESES

1. Traditional method has significant effect on academic achievement and retention of secondary school science students.

2. Multimedia approach (multimedia package-I and Multimedia Package-II) has
significant effect on retention and academic achievement of secondary school science students.

3. Multimedia approach (multimedia package-I and Multimedia Package-II) has significantly higher effect on total academic achievement and retention of secondary school science students as compared to traditional method.

4. Multimedia approach (multimedia package-I and Multimedia Package-II) has significantly higher effect on academic achievement and retention of secondary school science students as compared to traditional method according to the different instructional objectives.

5. Multimedia approach (multimedia package-I and Multimedia Package-II) has better significant effect on academic achievement and retention of secondary school science students as compared to traditional method at varying levels of intelligence.

6. There will be a favourable opinion of students about learning through multimedia approach.

1.16 DELIMITATIONS OF THE STUDY

1. The study was delimited to one English medium Secondary School (Ramjas Senior Secondary School) of Sonepat district.

2. The study was confined to one unit of General Science ‘Fundamental Unit of Life’.

3. The study was confined to only two methods of teaching i.e. traditional and multimedia.

4. The study was confined to the students of class IX.