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REVIEW OF RELATED LITERATURE

2.1 Introduction

The review of related studies throws light on the nature of work done in the area and helps the investigator in designing the study, formulating the objectives and selecting the methods, tools and techniques of the study.

In this chapter attempt has been made to closely examine if there is any empirical evidence to support the assertion that multimedia improves effectiveness. It is also aimed to derive scientific conclusions based on various studies done by educationists, practitioners and teachers in the following different areas. At present the most commonly used education method is classroom instruction.

2.2 Studies Related to Various Media Based Instructional Strategies

Carmigani (1973) found that learning activity modules are effective in high school students to learn cognitive and psycho motor skills.
Observation of Windell (1975) showed that the self-instructional teacher training modules are effective to produce reliable changes in trainees' knowledge and skill in the use of techniques for determining reading level of the children.

Shah (1979) states that the teachers who were exposed to the treatment of self instructional multimedia course on effective questioning showed significant improvement in all the skills except one, in the context of micro teaching.

Basu (1981) developed a multimedia programme using semi programmed text, tape-slide, work book, film, kit transparency etc. And concluded that this strategy enabled learners to reach the level of mastery learning

While Varghese (1981) experienced the higher effectiveness of teacher assisted programmed approach over the conventional approach in teaching Biology in Kerala high schools, Ravindranath (1992) observed the inductive and deductive programmed learning methods are equally effective and more than conventional method in teaching Biology in schools of Baroda.

Golani (1982) explained the non-availability of trained personnel in audio-visual education; problems of equipments,
inexperience in production of materials and lack of guidance are some of the reasons for declining the technology based education in secondary schools.

Pereira (1982) found out that audio-laboratory method is more effective than formal method of teaching in science and it is superior in the attainment of higher objectives like understanding, application and skill in primary school children.

Ravindranath (1982) in his study on development of multimedia instructional strategy for teaching science at secondary school level noted that the strategy was effective to the extent that 70 percent of the experimental group students obtained 60 percent and above on all unit tests.

A multimedia package for teaching a course on audio-visual education including programmed slides programmed print material non-projected visual aids, self instructional materials etc. was developed by Krishnan (1983) and was found quite effective.

Seth (1983) described that educational television programme increases the language development, higher acquisition of information and learning efficiency in children.
Singh (1983) strongly advocated that the use of media treatment in the teaching-learning process is capable of creating high scores in students.

Through his research Vardhini (1983) shows that for achievement of different instructional objectives, a systematically validated multimedia strategy can be implemented at school level with suitable cost and time components.

Greenberg (1984) compared the effectiveness of computer assisted videocassette lessons with that of videocassette lessons and paper-pencil practice. The findings revealed that there was no significant difference existed between the post test performances of the two groups.

Menon (1984) used a multimedia approach and validated the strategy for postgraduate levels in different areas and found it satisfactory.

Wed (1984) investigated the scope of media based communication using documentary analysis and library research and opined that scope of media is restricted because lack of adequate participation of students, teachers and parents in these programmes.
In an attempt by Ginapp (1985) the influence of teacher assessment module tapes on student teachers' performance showed that students in the experimental group received higher overall ratings by groups of student teachers, supervising teachers and co-operating teachers indicating the effectiveness of module tapes.

The results of the experiment designed by Horton, Lovitt and Givens (1988) demonstrated the effectiveness of computer-assisted instruction for teaching content terminology to high school students by classifying as learning disabled, remedial or in general education.

Lang (1989) has tackled the topic academic development and preparation for work, a highly neglected area and found that a very little work is done in academic subjects such as science, mathematics and social studies in the education of hearing impaired students.

Lowerbraun and Thomson (1989) have described research designed to discover the relative efficacy of the new and old approaches and to make recommendations for further research as well as regulatory and policy changes. They also stressed the need to study the effectiveness of use of new media and technology such as
captioned films, transparencies programmed instruction sequences computer software etc.

Goel and Mahajan (1990) in their study on computer-based question bank at B.Ed level observed that Science group scored significantly higher than the Arts group but no significant difference existed between males and females, Maths and non-maths students on their achievement in computer education.

Koul and Bhadwal (1991) indicated that instruction using linear programmed text on 'Atomic structure' effectively reduced test anxiety among students compared to conventional method of teaching irrespective of the use of formative evaluation tests.

Sinnathambi (1991) developed a video programme on energetics in chemistry for higher secondary students and Samy (1991) prepared a video programme to teach Tamil vocabulary for sixty grade students. Both of them conclude that the performance of experimental groups were superior to the control group.

The studies by Madhumohan (1990), Santhoshkumar (1990), Mollykutty (1991), Gopalan (1992) and Jissy (1997) confirm the superiority of teacher study module over the traditional text book approach in teaching high school chemistry, high school Physics.
Madhumohan also found that computer assisted instruction is more effective than modular approach.

Smith and Jones (1991) present recent changes in technologies, expansion of courseware, and distribution of courseware as a significant part of the undergraduate chemistry curriculum at the University of Illinois since 1986.

The findings of the study conducted by Jayamani and Chandramani (1992) revealed that the experiment which used simulation model of teaching through computer assisted instruction was significantly better in performance than the control group which used the traditional method, but sex wise comparison proved to be insignificant.

Katz and Pyryt (1992) undertook a project that focuses on improving students' self-image, self motivation and decision making skills by using technology like audio cassette, microphone, video animation and computer software package, for sixth grade students.

Litchfied (1992) identified different factors such as the nature of the investigation, advantages of the programme over a laboratory investigation, number and types of higher order thinking skills required, concepts related to inquiry and the level of inquiry are the.
evaluation criteria that may be used to determine the usefulness of science education computer software.

According to Yang (1992) and Crain (1994), computer based instruction provide better opportunity for creativity, sustained motivation and immediate recall of learnt facts.

Couch (1993) gives the importance of visual literacy along with scientific literacy among middle school students in the teaching of earth and life science classes.

Arbour (1994) developed a multimedia package that includes video cassette, a guide, six posters to provide a teaching outlines on Great Lakes Fisheries for middle and high school. The package was found effective in both formal and informal school settings.

Beichner (1994) examined the cognitive and affective impact of multimedia editing to promote science learning. He also found that students were highly motivated to work cooperatively and without teacher supervision in such environments.

Investigation of Kanning (1994) describes that the multimedia approach is most successful in helping students to reach existing curricular goals.
Burton (1995) experienced the effectiveness of Computer Assisted Instruction over traditional instruction on academic performance of adult students in Mathematics and reading sections of the Test of Adult Basic Education. Age and sex had no effect on the method of instruction.

Herimann and others (1995) suggested that interactive child initiated software packages can stimulate reading and communication but a detailed planning and monitoring from teachers, parents and clinicians are required in the case of children with autism.

Sewell, Stevens and Lewis (1995) found out that the overall response of undergraduate students using multimedia computer packages were favorable. The study concluded that multimedia computer technology presents a powerful aid in the teaching and assessment of biological science.

Callaway (1996) identified that effectiveness of an interactive multimedia computer package designed to accommodate a number of cognitive and learning style is much higher for learning difficult topic such as ‘photosynthesis’ for high schools than the typical classroom method.
A science curriculum based on technology and student-centered learning for high school students was developed by Ebert and Strudler (1996). They found that creativity, interest, performance and work habits of the students increased tremendously using low cost multimedia.

Studies conducted by Edmundson (1996) showed that computer assisted instruction students performed significantly better in their achievement of intermediate English.

Hardy and Jost (1996) found that the inclusion of music can stimulate and operate in the mental processing of computer supported instructional messages in ninth grade lessons on physical science topics.

Steyn, Alexander and Rohm (1996) established the learning outcome of the computer-aided lessons for first year analytical chemistry by comparing the results of students obtained for an assignment. Although results of the students who did the course were significantly better only at 80% confidence level, they responded positively and wanted more exposure to computer.
Adamson (1997) found that student gender did not have a significant effect on either interactions of attitude in multimedia instruction and students in mostly female groups scored significantly higher than mostly male or equal gender groups in their performance for small group learning.

Cavender and Rutter (1997) described some of the multimedia techniques that address the difficulties in teaching both large introductory and small advanced level classes in the life science.

Research work of Crosby and Iding (1997) examined high school students' performance on an interactive multimedia computer tutorial for learning Physics concepts in conjunction with their individual differences and indicated that this approach is more effective.

Hedberg and others (1997) developed a package incorporating high quality visual material in the form of graphics, sound, text and video for high school students which challenges the students to become active participants and investigators in the learning process.

Lafronza (1997) examined the effects of different software formats on learning process by varying the degree of structure employed in a computer assisted learning environment and arrived at
the conclusion that cognitive styles play significant role in adult learners, performance.

Lalley (1997) compared the effectiveness of textual feedback to video feedback that included sound during computer assisted learning and indicated that video feedback resulted in superior learning and comprehension than text and students preferred video to text as feedback.

Reddy (1997) studied the effectiveness of multimedia instructional strategy in teaching science to slow learners and the result reveals that it enabled the slow learners to cope with normal students to a considerable extent.

From his study Schnakenberg (1997) showed that a relatively full version of computer-based instructional program is more effective for improving student achievement and learner control in an instructional program is more appealing for students than program control.

Shoba (1997) studied the efficacy of learning contract as a self instructional tool for learning Biology at the secondary school level and arrived at the inference the learning contract approach is
superior to the conventional teaching procedure in terms of students' achievements.

Watts (1997) opined that to realize the high potential for interactive language-learning multimedia, designers must develop a more learner-based orientation as the primary feature of designing.

Ayres and Melear (1998) found that there is increased learning of physical science concepts via multimedia when compared to the traditional hands-on exhibit in a science museum.

Emerson and Mosteller (1998) conclude that computer technology can support good teaching and can provide active participation. They also found that multimedia has advantages using multiple senses and can accommodate varying needs of students and enhance learning efficiency.

In his study, Madanakumar (1998) found that media based instructional strategy is more effective in creating environmental theory and application awareness that conventional text book approach among primary school pupils of Kerala.

Mehryar (1998) conducted a survey on the effectiveness of a web-based interactive multimedia system in tertiary education. The
results of the survey conducted during the course indicated that students were enthusiastic towards the new multimedia packages.

Yasmin et al. (1998) designed a project on collaborative educational multimedia and the findings indicated that students improved significantly in their science understanding programming skills.

Luppicini (2007) studied on recent developments in computer-mediated communication (CMC) research for educational applications. The review draws on 170 recent research articles selected from 78 journals representing a wide range of disciplines. The review focuses on peer-reviewed empirical studies, but is open to a variety of methodologies. The review is divided into two sections addressing major areas of current research: (a) general CMC research in education, and (b) factors affecting computer-mediated learning. The review covers a variety of key research areas revolving around CMC in education, including, media effect and comparison, on-line courses and networks, course and program evaluations, learning and learning processes, problem solving, writing, decision-making, argumentation, group decision-making, group dynamics, peer evaluations, gender differences, anonymity, teaching practice effects, technology integration, teacher styles and characteristics, socio-
cultural factors, and professional development effects. Findings suggest partial advantages of CMC in writing, task focused discussion, collaborative decision-making, group work, and active involvement in knowledge construction during group interactions. Other research findings revealed influences of peer interaction, group composition, group cohesion, goal commitment, group norm development, and process training, mixed-sex groups, and virtual cross-functional teams. Mixed-findings are revealed for performance advantages of computer-mediated versus face-to-face learning environments on various tasks and for the presence of gender differences in computer-mediated environments.

Sorgo (2010) experienced in his study, about two-thirds of Slovene secondary schools received computers equipped with data loggers and sensors to be used in teaching Physics, Chemistry and Biology. Later it was recognized that only a couple of Biology teachers were using the donated equipment in their classrooms or laboratories. The questionnaire, intended to investigate the situation, was posted to schools which had received a donation. Based on the answers, it was possible to assign computer applications from one of the three groups. In the first group were these applications (word processing, e-mail and internet use) towards which teachers have
positive attitudes and that they do use for school work. The common element is that teachers can work at home and then use the materials in the classroom. In the second group were applications (presentations, use of data loggers, computer programmes and virtual laboratory) towards which attitudes are positive, but which teachers do not use because of the overloaded curriculum, lack of equipment, and inappropriate training. In the third group are applications (computer games and programming), about which attitudes are negative and which teachers do not use. The introduction of such applications into teaching is at the moment far from realistic.

2.3 Studies Related to Computer Assisted Instruction

Studies conducted by Atkinson (1968) showed that computer assisted instruction students performed significantly better in their achievement in reading at Stanford’s computer assisted instruction programme than their peers in normal classrooms.

In a review of empirical studies on CAI, Cotton (1997) concluded, among others, that the use of CAI as a supplement to conventional instruction produces higher achievement than the use of conventional instruction alone, research is inconclusive regarding the comparative effectiveness of conventional instruction alone and
CAI alone, and that computer-based education (CAI and other computer applications) produce higher achievement than conventional instruction alone. In addition, students learn instructional contents faster with CAI than with conventional instruction alone, they retain what they have learned better with CAI than with conventional instruction alone, and CAI activities appear to be at least as cost effective as and sometimes more computer assisted instruction has been found to enhance students' performance than the conventional instructional method in counselor education (Karper, et al, 2005). However, Mill's (2001) findings revealed that CAI was found to be as effective as classroom for fact based learning, but not as effective for topics requiring critical thinking or mathematical problem solving. In addition, the time required for by learners to use CAI was higher overall than conventional classroom instruction. Students taught using traditional instruction combined with the use of computer performed significantly better than students taught using traditional instruction in a college setting Akour, (2006). Similarly, college students taught statistics using lecture-plus-CAI obtained higher averages on midterm and final exams than students taught using lecture method only Basturk, (2005). Based on a review of several studies and shortcoming on studies comparing CAI with conventional instruction, CAI can be considered as effective as
traditional instruction. Furthermore, how CAI is delivered can affect its effectiveness, and that new studies are needed to clarify the effect of CAI in contemporary student environment (Jenk and Springer, 2002). Thus, empirical findings on the use of CAI have been mixed.

Gender issues too have been linked with performance of students in academic tasks in several studies but without any definite conclusion. But there is a general conclusion that general imbalance exist in computer use, access, career and attitude. That is why Davies, Klawe, Ng, Nyhus, and Sullivan, based on their review suggested that current ender imbalance in technology and the role that technology will play in the future should be a concern for men and women, practitioners, policy makers and parents. Some studies revealed that male students perform better than the females in Physics, Chemistry, and Biology (Danmole, 1998; Novak and Mosunda, 1991; Okeke and Ochuba, 1986) while others revealed that female students are better off than males (Kelly, 1978: Wonzencreaft, 1963). Some studies such as those of Bello (1990) did not find any form of influence being exerted by gender on students’ academic performance in the sciences. Gender factor on the use of CAI has also been of interest to researchers. Collazos, Guerrero, Llana, and Oetzel, examined gender influence on collaborative use of computer based
communication. They found that group with minority women had low index of collaboration compared to homogenous group and group with majority women.

Zyoud (1999) reveal that when the computer is used to its full potential, it can help the students achieve more in learning vocabulary, grammar and comprehension to the learners with different IQ, motivation and attitude. It helps the students learn better because it provides them with a lot of freedom and responsibility to learn at their own pace. The students were found to have positive attitude towards Computer Assisted English Language instruction.

Khirwadkar (1999) developed a CAI package in subject of Chemistry for standard XI Science Students studying GSTB syllabus and studied the effectiveness of the developed software in terms of instructional time and achievement of students. Also, she studied the effect of software package on students' achievement in relation to students' intelligence level, motivation level, and attitude towards the package and the attitude of the students and teachers regarding the effectiveness of the CAI package with respect to contents, presentation, examples, illustrations, graphs and figures, evaluation items, utility of software and instructions given in the instructional
manual. The developed software package was found to be effective in terms of academic achievement of the students. The students and teachers were found to have favorable opinion towards the software package. There was found an interaction effect of IQ, motivation and opinion of students on their academic achievement.

Christmann and Badgett, (2000) made a progressive comparison of the effectiveness of computer assisted instruction on science achievement: This study compared science students who were exposed to traditional methodology with those who received traditional methodology supplemented with computer-assisted instruction (CAI). From the 24 conclusions, an overall mean effect size of 0.266 was calculated, indicating that, on the average, students receiving traditional instruction supplemented with CAI attained higher academic achievement than did 60.4% of those receiving only traditional instruction. The effect sizes were categorized into four subject areas. In descending order, the mean effect sizes in general science, Physics, Chemistry, and Biology are: 0.707, 0.280, 0.085, and 0.042, respectively. Differences in educational settings revealed that CAI is most effective among science students in urban areas; followed by those in suburban areas; and weakest among rural students. However, a -0.335 correlation between effect size and years
indicates that the effect of CAI on academic achievement has declined during this period.

Sanjna (2001) conducted a comparative study of the effectiveness of CAI and CMI on Pupil’s achievement in Science, their self concept and study involvement. Both CAI and CMI were found to be contributing significantly towards the achievement of pupils in science, in developing their self concept and in increasing their study involvement.

Spence (2004) found no significant influence of gender on the achievement of college students in mathematics when they were exposed to mathematics courseware in online and traditional learning environment. However, female online learners were significantly less likely to complete the course compared to their traditional female counterpart or male online counterparts. In a review of studies on access, use, attitude, and achievement with computer, Kirkpatrick and Cuban (1998) concluded that when female and male students at all levels of education had the same amount and types of experiences on computers, female achievement scores and attitudes are similar in computer classes and classes using computer.
Cooperative learning is meant to enhance students’ learning and develop their social skills like decision-making, conflict management, and communication (Bonwell and Eison, 1991). Through cooperative learning methods students share ideas together so that they can learn to work together and to learn that they are responsible for one another’s learning as well as their own learning (Slavin, 1991). Cooperative learning tends to be more carefully structured and delineated than most other forms of small-group learning (Newberry). Four key elements of cooperative learning are: positive interdependence, individual accountability, group rewards, and group training (Johnson and Johnson, 1987; Slavin, 1995). The close affinity and links between technology had been noted by Millis and Cottell (1998) in their assertion that cooperative learning and technology are natural partners. This is because use of technology involves human dimensions of caring, community, and commitment. Furthermore, using technology in ways that promote sequenced learning within groups can lead to more in-depth processing of course content and, hence, more retention of information.

Communication is at the heart of Knowledge Transfer (KT). But studies of KT barriers do not explicitly consider the relationship and impact of specific communication modalities on KT. The modalities of
Computer-Mediated Communication (CMC), namely email, Voiceover, Internet, Protocol, Instant Messaging (IM) and the like are generally viewed as a group 'CMC'. David Schwartz(2001) conclude with a model that presents the categorized KT barriers in a communication channel model that can be addressed by CMC modalities and that can potentially break down those barriers.

In a study effectiveness of CAI in Biology at Secondary School Level (Sivraj Pandian, 2004) reveals that the CAI students demonstrated significantly higher achievement gains in Biology. The variables self-esteem, attitude towards Biology and computer were influenced by the CAI. In contrast the attitude of students towards school could not be influenced.

Ann, Barbara, and Deborah (2009) have studied effectiveness of computer assisted instruction for teaching consumer credit. This study tested the effectiveness of computer-assisted instruction (CAI) versus supervised reading for teaching consumer credit to secondary school home economics students and investigated the effects of students' IQ, grade point average, attitude toward computers, and familiarity with computers on amount of information learned by subjects taught by CAI. A random sample of 68 students, randomly
assigned to experimental and control groups, was drawn from a population of X through XII graders in a large rural high school. Analysis of covariance, controlling for differences in IQ and grade level, was used to test differences in mean gain scores of pre-test, post-test, and second post-test. Results indicated that the experimental (CAI) group learned more between pre-test and both post-tests than did the control group. Results of three stepwise multiple regression analyses indicated that student learning via CAI did not vary by IQ, GPA, attitude toward computers, or familiarity with computers, which suggests that CAI is an effective teaching method for teaching consumer credit with diverse types of high school students.

Barad (2010) in his study the Effectiveness of CAI for Science teaching in urban area. It reveals that science teaching through CAI programme was equal effective for boys and girls. Science teaching through CAI programme was more effective for high IQ students then low IQ students. Effectiveness of sex was shown of teaching method was shown on mean achievement score of post-test. Effectiveness of IQ was shown on mean achievement score of posttest. Interaction effects of sex and teaching method was not shown on mean achievement score of post-test. Interaction effects of sex and IQ was
not shown on mean achievement score of post-test. Interaction effects of teaching method and IQ was not shown on mean achievement score of post-test. Interaction effects of sex, teaching method and IQ was not shown on mean achievement score of post-test.

Owusu, (2010) Studied the effects of computer-assisted instruction on performance of senior high school Biology students in Ghana. This study investigated the comparative efficiency of computer-assisted instruction (CAI) and conventional teaching method in Biology on senior high school students. A science class was selected in each of two randomly selected schools. The pre-test-post-test non equivalent quasi experimental design was used. The students in the experimental group learned science concepts (cell cycle) through the CAI, whereas the students in the control group were taught the same concepts by the conventional approach. The conventional approach consisted of lecture, discussions and question and answer teaching methods. Mann-Whitney U tests were used to analyze students’ pre-test and post-tests scores. The results indicated that students that were instructed by the conventional approach performed better on the posttest than those instructed by the CAI. However, the performance of low achievers within the experimental group improved after they were instructed by the CAI.
Even though the CAI group did not perform better than the conventional approach group, the students in the CAI group perceived CAI to be interesting when they were interviewed.

2.4 Studies Related to Multimedia Based Instruction

Multimedia is a term that has been used by educators and those in the industry for many years. It has numerous definitions throughout the literature. In the 1960’s, the term multimedia meant the use of several media devices in a coordinated fashion (for example, synchronized slides with audiotape); it also described the combined use of several media, such as films, video, and music.

Najjar (1996) described multimedia as the simultaneous presentation of information using more than one mode of information transmission. It combines the use of various media such as text, graphics, animation, pictures, video, and sound, to present information. The term also has been used to refer to everything from slide shows to extravaganzas complete with multiple monitors, animation, video, sound, and text.

Borsook and Wheat (1992) state that it would be easy to remember that multimedia stands for multiple media except that the
term media can mean many things. 'Media' can include slides, audiotapes, videotapes, videoconferencing, animation, films, music, voice, paper, or even someone shouting through a megaphone. Media can be instructional or not; it can be interactive or not; and it can be computer-based or not.

Poole (1995) explained that multimedia has become closely associated with the computer controlled instructional delivery systems. Instead of using several devices to present multiple forms of media, these media are now presented using one device (Kozma, 1987).

Moore et al. (1996) augmented this point by noting it is obvious that the computer plays a central role in the organization of the learning environment.

Lee (1996) describes computer-mediated multimedia (CMM), as the integration of two or more communication media, controlled or manipulated by the user via a computer, to present information. CMM can be combinations of text, images, animation, sound, color, and video in a single, computer-controlled presentation. The computer also allows the element of interactivity. Therefore, there has been a virtual explosion of the use of computer-based multimedia
learning (Bagui, 1998). It can then be speculated that as technology and software continue to improve and costs decrease, multimedia usage will continue to increase.

Liao (1999) Effects of multimedia on learning in third world children, multimedia is increasingly being used in computer-based learning, and the general indication is that this trend will persist for a while to come. One rationale for this trend is the assumption that multimedia has properties that can aid learning, particularly the learning of abstract subject matter. One area that has long been seen as a target for the use of learning aid is children’s learning. However, although the use of multimedia in this area is rapidly increasing, particularly in the form of numerous commercial applications, there still appears to be a lack of adequate research into the extent to which multimedia is effective in childrens’ mathematics, given factors such as culture and environment. This study 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. The implication of this finding is discussed.
Eva and Smitek (2006) studied the designing of multimedia instruction and its advantages in education. The researchers conducted a survey among students who used the multimedia instruction in their course. Students involved in the survey found the lessons understandable and systematic, very interesting and very carefully prepared. They felt that these lessons would enable them further independent study. They were enthusiastic about the self-assessment tests, which helped them to find out whether the information learned was right or wrong. The study showed that students were satisfied with this kind of studying and were looking forward to using computer-based multimedia learning material for other subjects as well. It claims that the use of multimedia instruction adds variety to the study and increases the quality of an individual's work and the motivation of learners.

Desai (2004) found out the relative efficacy of teaching through the traditional method and the multimedia approach in the subject of Home Science, particularly, Proteins. Mean achievement of the experimental group was found significantly higher than that of the control group. From post-test to retention test almost equal reduction in performance was found in both the groups. The study has arrived at significant findings when caste, location, income, Std. XII
examination marks, and IQ of the students were considered as co-
variables. The students were found to have favorable opinions.
towards the multimedia approach.

A leading researcher in the area of multimedia effects on
instruction and learning has been Mayer (Mayer, 1997; Mayer et al.
2003; Mayer, et al. 2003; Mayer and Moreno, 2003). He asserts as a
seminal premise in one of his earlier efforts that his research has
indicated that presenting verbal explanations alone in instructional
situations is less conducive to learning for some students than
presenting verbal explanations in conjunction with multimedia. Thus
it is proposed that the generative theory of learning best accounts for
the type of learning related to multimedia use. It is mentioned that in
a generative theory of multimedia learning, the learner is viewed as a
knowledge constructor who actively selects and connects pieces of
visual and verbal knowledge. The basic theme of a generative theory
of multimedia learning is that the design of multimedia instruction
affects the degree to which learners engage in the cognitive processes
required for meaningful learning within the visual and verbal
information processing systems. Mayer reviewed eighteen studies in
which students did better on problem solving when presented with
verbal and visual formats and an additional six studies that indicated
that multimedia worked best for students with low prior knowledge and high spatial ability. Thus, it was concluded by noting that current uses of multimedia too often focused on, "what computers can do rather than on a research-based theory of how students learn with technology".

Shapira and Youtie (2001) reported the results of an experiment with multimedia and distance learning that had several points of resemblance with the current action research effort. An online seminar on industrial modernization was offered in 1997 that used the Internet to convey multimedia content to remote learners in conjunction with those on site. The classes were held in a multimedia classroom with audio transmission capabilities to remote sites. Guest speakers prepared slides that were posted to a course web site prior to seminar sessions, so that remote students could view the slides while concomitantly listening to speakers' voices. The audio files were then added to the slides on the Web site after the class so that students could revisit the lecture as often as they wanted. The results of this study showed increased times for preparations of multimedia classes, a plethora of delimiting technological glitches, and high levels of recall for material both heard and read. The authors concluded that while pragmatic considerations dominated
Moreno and Mayer (1999) looked for cognitive principles that could guide efficacious uses of multimedia; based on the premise that multimedia has traditionally been used in relation to available technological capacities. The researchers conducted two experiments to examine the effects of two cognitive principles associated with multimedia, that is the contiguity principle and the modality principle. They state, "The contiguity principle... states that the effectiveness of multimedia instruction increases when words and pictures are presented contiguously in time or space". The modality principle relates to the premise that auditory presentation results in higher recall than visual presentation. They cited experiments which evidenced superior learning when material was presented in the auditory mode.

In the first experiment, the goal was to distinguish between contiguity and modality effects in multi-mediated instruction. One hundred thirty-two university students were divided into three groups, which received various arrangements of text and graphics, to measure spatial contiguity effects. The second experiment, using a similar population of students, received text and graphics multimedia
either concomitantly or non-concomitantly, to measure temporal contiguity effects. The results of these two experiments supported both the contiguity and modality principles as valid considerations for determining optimal uses of multimedia.

In an important research effort that involved the analysis of instructional scenarios that included multimedia, Mayer and Moreno (2003) discussed endemic theoretical ambiguities involved in the use of multimedia. They state: We define multimedia learning as learning from words and pictures that are intended to foster learning. The words can be printed (on-screen text) or spoken (narration). The pictures can be static (illustrations, graphs, charts, photos, or maps) or dynamic (e.g., animation, video, or interactive illustrations).

Morrison and Frick (1993) go on to identify the goal of multimedia instruction as meaningful learning, or learning that requires deep processing. In opposition to meaningful learning is what the authors' call, cognitive load, which relates to the limits of learning from multimedia. The human mind is said to process information on two channels: “an auditory/verbal channel for processing auditory input and verbal representations and a visual/pictorial channel for processing visual input and pictorial representations”. A conflict naturally occurs in using dual channels
for acquiring learning material, in that the channels can be overloaded.

This research is portrayed as an effort to achieve meaningful learning with reduced cognitive load by identifying optimal uses of multimedia that interfaces with learners two channels of sensory input in a least taxing way. Skillful manipulation of the multimedia in relation to the two channels of input to reduce cognitive load on the one hand, and to allow meaningful learning on the other, is achieved by nine techniques:

1. Off-loading: or balancing input between the two channels;
2. Segmenting: or placing time segments between content segments;
3. Pre-training: or pre instructing students on content;
4. Weeding: or removing extraneous content;
5. Signaling: or placing coding clues into content;
6. Aligning: or optimally placing text and graphics;
7. Eliminating redundancy: or avoiding identical spoken and written content;
8. Synchronizing: or presenting related graphics and narration simultaneously;
9. Individualizing: or prescreening individual learners for required cognitive skills. (Mayer and Moreno, 2003)

The last article in the review (Mayer et al, 2003) builds on previous studies by adding a degree of specificity to the considerations involved in creating optimal multimedia. The premise of this study is that traditionally, multi-mediated learning has been characterized as a form of information delivery; however, the premise of this study is that multi-mediated learning can be construed as social conversation based on the theory of social agency. As the authors state, “The main thesis in social agency theory is that social cues in a multimedia message can prime the social conversation schema in learners”. The authors hypothesized that students contracted more meaningful learning from multimedia when it induced social agency in them.

In the first of two experiments conducted to test the social agency hypothesis in relation to multi-mediated instruction, half of sixty-eight participants received narration in a computer-based, multi-mediated lesson spoken by a male, native English speaker, while the other half received the same narration from a male speaker with a Russian accent. The results of this first experiment showed that the difference in narrators did not affect retention of material
from the lesson but did significantly affect transfer of learning as evidenced by problem solving transfer, in favor of the non-accented voice. In the second experiment, one voice was a male, native-English speaker, while the other was a male, machine-synthesized voice, and here, voice difference affected significant differences in learning related to retention and transfer. The researchers concluded that the social agency induced by a more familiar voice narration in the multi-mediated instruction improved retention and transfer of learning. The practical implications of the study were to add a voice principle to considerations of optimal uses of multimedia, based on the theory of social agency, and as a complicating factor for consideration in addition to cognitive load theory.

Web-based learning represents a common use of multimedia. This use of multimedia for educational purposes is growing rapidly, thus, the need for increased multimedia research. Fueled by several factors, this increase may be due to: a) decrease in multimedia computer costs, b) learners prefers to have multimedia in their educational situations, and most importantly, c) people believe that educational multimedia improves learning. (Najjar, 1996).
Kulik et al, (1983) found in one study that recorded an 88% savings in learning time with computerized instruction (90 minutes) versus classroom instruction (745 minutes) and another study that recorded a 39% savings in learning time (135 minutes for computerized instruction versus 220 minutes for classroom instruction). Kulik et al, (1986) identified 13 studies in which students using computers mostly for tutoring learned in 71% less time than students in traditional classroom instruction. In a comparison involving eight studies,

Kulik et al, (1980) found that computer-based instruction took about 2.25 hours per week while traditional classroom instruction took about 3.5 hours, a 36% savings in learning time.

The usage of multimedia has not always given good results. Severin (1967) study, animal name recognition accuracy was highest when children were presented the names via simultaneous audio and pictures (verbal and nonverbal channels). However, children who received the same information via audio and print (two verbal channels) did not outperform students who received the information via print alone (verbal channel).
In a classroom test, Samuels (1967) found that a related picture accompanying a simple short story interfered with the ability of poor first grade readers to learn to read the 50 words in the short story. In a laboratory study, Samuels (1967) presented words alone or words with identifying pictures to kindergarten children who were learning to read four words. After the children saw each word or word and picture, the experimenter read the word to the children. When the experimenter tested learning using only words, the children who saw only words performed better than the children who saw words with pictures. For this latter test, it appears that the pictures distracted the children. A review of related literature (Samuels, 1970) also concluded that pictures interfered with learning to read.

Khirwadkar (1999) the developed software package which was found to be effective in terms of academic achievement of the students. The students and teachers were found to have favourable opinion towards the software package. There was found an interaction effect of IQ, motivation and opinion of students on their academic achievement.

Yadav (2000) conducted the effectiveness of the computer software for students of standard I. There was a significant gain in terms of mean achievement on the software on Alphabets and
Animals. Most of the students were found to have positive reactions towards the software. Teachers welcomed the media integrated approach towards learning.

Starbek et al, (2010) have experienced that teaching genetics with multimedia results in better acquisition of knowledge and improvement in comprehension. The main goal of this study was to explore whether the use of multimedia in genetics instruction contributes more to students' knowledge and comprehension than other instructional modes. Study also was concerned with the influence of different instructional modes on the retention of knowledge and comprehension. In a quasi-experimental design, four comparable groups of III and IV grade high school students were taught the process of protein synthesis: group 1 was taught in the traditional lecture format (n = 112 students), group 2 only by reading text (n = 124 students), group 3 through multimedia that integrated two short computer animations (n = 115 students) and group 4 by text supplemented with illustrations (n = 117 students). All students received one pre-test in order to estimate their prior knowledge and two post-tests in order to assess knowledge and comprehension immediately after learning and again after 5 weeks. Results showed that students comprising groups 3 and 4 acquired better knowledge
and improved comprehension skills than the other two groups. Similar results were observed for retention of acquired knowledge and improved comprehension. These findings lead to the conclusion that better learning outcomes can be obtained by the use of animations or at least illustrations when learning genetics.

2.5 Studies Related to Multimedia in Biology Instruction

The science education community emphasizes the implementation of inquiry-based instruction in both primary and secondary schools. Reform-driven publications in science education emphasize the importance of inquiry both as an instructional method and as a learning framework (AAAS, 1989, 1993, 1998; National Research Council, 1996). Teaching science via inquiry involves engaging students in the kinds of processes used by scientists. These processes include asking questions, making hypotheses, designing investigations, grappling with data, drawing inferences, redesigning investigations, and building and revising theories (Kubasko, et al. 2007).

Bridget and Danner (2007) study was to investigate student perceptions of Virtual Biology labs used in two online introductory Biology courses. Students completed an online survey, containing
Likert type and open ended items, about perceptions of the CDROM based Virtual Biology laboratories and face to face (F2F) laboratories they completed during the courses. Findings indicated that though most students (86.9%) perceived the F2F laboratories as more effective than the virtual laboratories across several criteria, many of them (60.8% on one criterion) perceived the virtual laboratories as effective as well. The authors discuss how student identified issues related to interactivity and feedback could be influenced by the design of the learning experience, virtual laboratory tool, and/or the use of synchronous collaboration tools. Additionally, the authors include suggestions for future research on the use of virtual Biology laboratories in the online setting.

Hennessy, et al. (2006) discussed ways teachers make use of computer-based technologies to support the learning of science, and suggested that technology supports stepwise knowledge building and application. Such applications have implications for both curriculum-related science activities and emerging computer-based learning technologies. Technology helps students construct links between theories and phenomena by extending the human capacity.

Yan and Treagust (2004) suggested that Biology educators are increasingly using technology to supplement their teaching. A variety.
of computer technologies have been used over the past two decades to enhance student learning of many of the biological sciences in colleges and universities. Computer technology and educational software has provided new learning opportunities that can change the look and feel of traditional science classrooms. This does not necessarily imply that learning in traditional education is ineffective. However, traditional methods sometimes fail to reflect skills and interests of students who have grown up in the digital age. Technology can enhance learning environments and increase opportunities for authentic hands-on experiences (Zumbach et al, 2006). Computer technologies support the development and implementation of teaching and learning strategies that support many important science skills (Maor and Fraser, 1996).

Schoenfeld-Tacher, et al. (2001) mentioned that technology and multimedia facilitates the knowledge-construction process for students by allowing learners to construct links among their prior knowledge and the new concepts. This assertion supports research suggesting that science education should include both constructivist methodologies and technology integration as a natural part of its ideology. Computerized magnification systems and video-based virtual experiences have been studied in the attempt to improve areas
such as the ease of viewing, interactivity, and improvement of group learning activities within the context of science education. Downing (1995) noted the size of the ocular as an inhibitor to communication and other dynamics within group learning situations and suggested the use of magnified images on video screens.

In the Harris et al. (2001) study of the replacement of light and stereo microscopes with a virtual imaging system, digital virtual experiences largely occurred in science coursework at the university level, with emphasis on potential in the medical and biomedical fields. Dee et al. (2003) stated that a comparison of virtual slides to traditional microscopy demonstrated that information technologies improved the identification of cellular structures by learners. Further information from the study indicates that the quality of the digital images is often superior to other formats.

Susanne et al. (2002) has studied cancer cell Biology and has experienced that a student-centered instructional module exploring the use of multimedia to enrich interactive, constructivist learning of science. Multimedia has the potential of providing bioscience education novel learning environments and pedagogy applications to foster student interest, involve students in the research process, advance critical thinking/problem-solving skills, and develop
conceptual understanding of biological topics. Cancer cell Biology, an interactive, multimedia, problem-based module, focuses on how mutations in proto-oncogene and tumor suppressor genes can lead to uncontrolled cell proliferation by engaging students as research scientists/physicians with the task of diagnosing the molecular basis of tumor growth for a group of patients. The process of constructing the module, which was guided by scientist and student feedback/responses, is described. The completed module and insights gained from its development are presented as a potential “multimedia pedagogy” for the development of other multimedia science learning environments.

Klein and Koroghlanian (2004) have investigated the effects of audio, animation, and spatial ability in a multimedia computer program for high school Biology. The study examined the effects of instructional mode (text vs. audio), illustration mode (static illustration vs. animation) and spatial ability (low vs. high) on practice and post-test achievement, attitude and time. Results indicated that spatial ability was significantly related to practice achievement and attitude. Participants with high spatial ability performed better on the practice items than those with low spatial ability. Participants with low spatial ability responded more positively
than those with high spatial ability to attitude items concerning concentration, interest and amount of invested mental effort. Findings also revealed that participants who received animation spent significantly more time on the program than those who received static illustrations. Implications for the design of multimedia are discussed.

Kachala and Bialo reviewed 311 research studies on the effectiveness of technology on student achievement. Their findings revealed positive and consistent patterns when students were engaged in technology-rich environments, including significant gains and achievement in all subject areas, increased achievement in preschool through high school for both regular and special needs students, and improve attitude toward learning and increased self-esteem.

Paris (2004) stated that e-Learning can improve school results. Furthermore, a simple multimedia presentation helped the students to better understand a subject without the help of a teacher particularly for shy and weak students.

Whatannarang investigated and compared the effects of Internet-based teaching and learning systems and traditional
instruction on learners in the areas of quality of students' term papers, homework, reference sources, analytical ability, synthesis, and summarization of information, and time used for study. The samples were 80 graduate students randomly selected from the class of 4 subjects registered from the second semester of academic year 2000 to the first semester of academic year 2002. They were divided into 4 control groups and 4 experimental groups. The control groups studied with traditional instruction. The experimental groups studied with teacher-prepared instruction programs on the Internet-based system. Data were analyzed by using a one-way t-test for independent samples. The Pre-test and Post-test results indicated that there was no negative effect on the learners. The scores of experimental groups were not significantly higher than the scores of the control groups in the area of quality of students' term papers, homework, reference sources, and analytical ability, synthesis and summarization of information. However, the experimental groups spent significantly less time.

McLaughlin and Arbeider (2008) have studied evaluating multimedia-learning tools based on authentic research data that teach Biology concepts and environmental stewardship. High school science teachers and students need interactive, multimedia research-
based learning objects that (a) support standards-based teaching, (b)
enforce complex thinking and problem solving, (c) embrace research
skills, (d) include appropriate assessments to measure student
performance, and (e) show real-world uses. To meet these five
criteria, the CHANCE modules have been purposefully designed to
allow students to “learn how things work” using real-world research
data. These modules pace students through images and text that
help them to interpret biological and ecological principles. Indeed,
each module has been carefully field tested with practicing in-service
and pre-service science teachers and real students to assure its
effectiveness. Notably, the integration of authentic scientific research
with sequenced, interactive computer simulations create a solid
curriculum base of national interest that has laid the groundwork for
additional materials collections that capitalize on the resources of
communities that surround schools in particular regions of the
country.

Ahmad (2010) in his study the effectiveness of innovative and
traditional methods of teaching Biology, and has experienced that
multimedia, is the combination of various digital media types such as
text, images, audio and video, into an integrated multi-sensory
interactive application or presentation to convey information to an
audience. The teacher uses multimedia to modify the contents of the material. It will help the teacher to represent in a more meaningful way, using different media elements. These media elements can be converted into digital form, modified and customized for the final presentation. By using multimedia or digital media in teaching Biology the students are able to learn better since they use multiple sensory modalities, which would make them more motivated to pay more attention to the information presented and retain the information better. There are many multimedia technologies that are available for developers to create these innovative and interactive multimedia applications. On the basis of the results and personal discussion in the group meeting of Biology teachers, it is concluded that Multimedia teaching is most effective in teaching Biology, as new software and high technologies like Animation software and Photoshop are available in market easily, which can also help students in understanding various aspects of Biology. The study recommended that there are many innovative teaching methods introduced to teach Biological Sciences and every method has its advantages and disadvantages. Therefore teacher should select methodology of teaching that suits the students for their effective learning. For effective teaching, the teacher should acquire mastery on the content as well as expertise and adaptability on methods.
Optimum opportunity should be provided to the students to actively participate in the teaching-learning process. Efforts should be made to make teaching-learning process to be learner centered. Appropriate software, new technologies and modern Audio-Visual aids like multimedia should be used to make the learning process effective as well as interesting.

Sangodoyin (2010) studied computer animation and the academic achievement of Nigerian senior secondary school students in Biology. This study investigated the effects of computer animation on the academic achievement of Nigerian senior secondary school students in Biology. The moderating effects of mental ability and gender were also investigated. The pre-test and post-test, control group, quasi-experimental design with a $2 \times 2 \times 2$ factorial matrix was adopted for the study. One hundred and eighty-nine senior secondary school Year II Biology students from two randomly selected Federal Government Colleges in two states in Southwestern Nigeria were the participants. Findings show that there is a significant main effect of treatment on students' achievement in Biology. The computer animation was effective in improving students' achievement therefore, computer animation is recommended as a means of teaching Biology to students in Nigerian secondary schools.
According to Ali (2004) the significant role of technology in teaching and learning is limited as an instructional delivery medium and not a key determinant of learning. It can only support the classroom learning.

Thus there is empirical evidence to suggest both the positive and negative effects of multimedia. The key is to analyze these findings and find out the precise reasons and the situations in which multimedia is useful and in which it is not. While Multimedia seems to be improving the learning rate, it is not a universal fact. In the next section contains discussion on the main conditions in which multimedia would be useful.

Today's teachers are concerned with how to use technology to enhance and enrich their learning environment. According to Cline, the role of technology in the classroom is not to replace traditional educational methods, it does act as an enhancement for teaching students to think critically, communicate creatively and solve problems in analytical way. Students can learn “from” computers – where technology is used essentially as tutors and serves to increase students basic skills and knowledge; and can learn “with” computers – where technology is used as a tool that can be applied to a variety of
goals in the learning process and can serve as a resource to help develop higher order thinking, creativity and research skills.

2.6 Conclusion

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

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

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