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Multimedia effectiveness in the learning environment : A review of literature

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Abstract

Multimedia Effectiveness in the Learning Environment: A Review of Literature examines some of the research and academic literature related to the use of computer-assisted instruction, hypertext, hypermedia and multimedia in the learning environment. Contemporary views of media psychology and learning styles are also discussed, as well as the impact of multimedia on teachers, students and learning. The author concludes by suggesting that the progressive teacher knows the importance of quality instructional design and will look for every opportunity to integrate appropriate multimedia into the learning environment.

Multimedia - Effectiveness in the Learning Environment: A Review of Literature

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CHAPTER ONE

Introduction

Multimedia technologies have matured. No longer are computer aided instruction, hypermedia, CD-ROMs, laser discs and other interactive technologies restricted to a few experimental classrooms. The CD-ROM in the home computer, and connections to the infinite resources of the Internet are perhaps as common in the mid 1990's as home VCRs in the 1980's. In addition, low-cost, high-powered interactive video game computers which connect easily to a home television, and fast-paced television offerings from MTV, Nickelodeon and others are raising a generation of students who are far more media-aware than many of their teachers. Casual observation of the author's fifth-grade son indicates that it is not uncommon for students to show the teachers how to use the computer or computer applications in the classroom. This presents challenges for educators to compete with the multimedia stimuli that students encounter outside the classroom. Further, it is important for teachers to create learning environments that engage and stimulate students as well as increase their retention of the subject matter. Many educators have recognized that "Multimedia is fast emerging as a basic skill that will be as important to life in the 21st century as reading is today" (Hofstetter cited in Jackson, 1996, p.2). The real challenge then, is to provide appropriate staff development opportunities for teachers, adequate resources, and to promote learning environments which encourage the use of electronic technologies.

Purpose

This paper examines some of the literature related to the use of multimedia, hypermedia and computer-assisted instruction in the learning environment. The changes in access to technology in both the home and school environment as well as the influence of fast-paced mixed media stimuli has been so dramatic in the last few years that much of the early research may need to be reevaluated in today's context. However there is a vast body of literature that will continue to have relevance as we examine learning styles, media psychology, and factors that influence learning and student outcomes.

Research Question

This literature review begins by posing the following question: What significant factors must be evaluated and addressed by educators in order for instructional multimedia to be effectively utilized and have a meaningful impact in the learning environment?

CHAPTER TWO

Literature Review

The search for relevant references related to multimedia effectiveness in the learning environment was a challenge of keyword searching. The use of ERIC, and other on-line and CD-ROM databases as well as the World Wide Web was the starting point for browsing. A keyword search on the word "multimedia" brought up thousands of hits or on the Web - tens of thousands of hits. Focusing the search by adding keywords of "effectiveness", "classroom", "instruction", "psychology", "CAI", "computer aided instruction", "hypertext", and "hypermedia" helped to narrow down the list. There were many significant papers and resources that were accessed via the Web, but it took some persistent weeding out to locate relevant works. The libraries at UNI provided access to the majority of the ERIC documents, books, journals and magazines. The libraries at North Iowa Area Community College and the Northern Trails Area Education Agency provided additional resources.

Multimedia, CAI, Hypertext and Hypermedia

This review begins by examining how others have defined multimedia. Wilson and Tally (1991), described multimedia as "an evolving set of teaching and learning tools that, in their most sophisticated form, combine motion video images, sounds, text and graphics in a computer-driven environment under the user's control"

(p.3). Hofstetter cited in Charp (1995), described the components that are necessary to be considered multimedia: A computer to coordinate what you see and hear and with which to interact; links that connect the information; navigational tools; and ways to gather, process and communicate your own information and ideas. "If one of these components is missing, you do not have multimedia" (p.4).

Glennan & Melmad (1996), traced the history of computers in education to sometime in the mid-1960s, note that computer-assisted instruction (CAI) became possible because of improvements in computer technology. New scientific hypotheses about learning largely based the research B. F. Skinner and others, as well as federally funded research and development funding aimed at improving the achievement of slow learners, spawned the development of interactive drill-and-practice software which is still a major school application of computers today. CAI may utilize multimedia technologies and techniques, but they are not a requirement of CAI, which can be simple text-based computer/student interaction. However, much of the research related to CAI in the learning environment can be extrapolated to apply to multimedia in similar conditions.

Hypertext provides an opportunity for the reader of text on a computer screen to quickly branch or jump from one piece of information to another. One way to describe hypertext is to imagine data arranged on electronic note cards. The information is connected by "links" that may be highlighted text or a button on the computer screen, allowing the user to choose his or her own path through the information, jumping from

card to card (National Education Association, 1994). As technology advanced beyond a text-only computer display it became possible to present information not only as text but to include still images, animation, audio recordings or video sequences.

The term "hypermedia" was originally used to indicate that the application had capabilities beyond those of simple hypertext (National Education Association, 1994). Hypermedia allows students to explore material in non-linear ways based on associations from one piece on information to another. Students can make their own choices and follow paths by linking from one text word or phrase, or from a picture or graphic to other related information. Several students accessing the same instructional presentation may each travel a different path to get the information: one may primarily read the text, while another may take advantage of the images and video sequences, each making choices based on his or her individual learning preferences (Baron and Orwig, 1993). Because of the versatility on presenting many different kinds of instructional information in a variety of ways, Relan and Smith (1996) have described hypermedia as an efficacious information delivery system.

For the most part, the term, multimedia, has replaced the use of the term hypermedia (National Education Association, 1994), although they are often used interchangeably. Multimedia (or hypermedia) provides possibilities that have not been possible with other delivery systems. When properly designed, an instructional unit can encourage repetition and additional review of the material, allowing the student an opportunity for improving or perfecting responses (Tuttle, 1991).

Media Psychology

In order to understand some of the challenges related to the development and effective use of instructional multimedia, one must have at least a basic knowledge of learning styles, brain research and educational psychology, as they relate to multimedia instruction and learning. While the subjects are too broad for a significant discussion here, there are a few theories and studies related to the use of multimedia which will be mentioned.

Brain hemisphere dominance is one way in which learning styles can be classified. People with left-brain dominance are believed to be primarily auditory learners, and those with right-brain dominance are believed to be primarily visual learners (Clemens, 1996; Springer & Deutsch, 1981; Vitale, 1982). Students in one study of adult learners with right-brained dominance (the visual learners) performed better with CAI or multimedia stimuli, while left-brain students (the auditory learners) were more successful in a traditional classroom lecture environment (Benedict and Coffield, 1989). "Multimedia can enable an accelerated learning process by combining the logical, linear and verbal left-brain hemisphere with the visual, creative and abstract right hemisphere" (Wood, 1995, p.21). Other researchers have explored additional factors that influence learning.

Gardner's (1983) work on theories of multiple intelligences defined seven different "frames of mind": verbal/linguistic intelligence, visual/spatial intelligence, musical intelligence, logical/mathematical intelligence, bodily-kinesthetic intelligence,

interpersonal intelligence, and intrapersonal intelligence. As one might surmise, each has a different learning style and responds to different stimuli. Assessing the learning styles of individual students should be an important consideration when designing instructional media.

Luskin (1996) described media psychology as a new and growing field and contended that multimedia developers had limited resources from which to learn about media psychology. What was referred to as the "new media psychology" included the study of how the mind and emotions respond to many different kinds of sensory stimuli.

In relating the technological capabilities of multimedia presentation and storage devices, Luskin (1996) stated that the quality of the audio, bandwidth of the video and color palette of the images displayed will impact the cognitive and emotional experience of the user. The designer must learn more about the "why" of media psychology to effectively use interactive technologies to "involve individuals in learning, positive growth, personal achievement and self-actualizing experiences" (p. 84).

Looking at psychology as a way of understanding why well-designed hypermedia may work, Borsook and Higginbotham-Wheat (1992) examined the studies and theories of how people learn, access and use information and ideas, then compared how hypermedia may mirror the way the brain works. While they discussed a number of theories, the "cognitive flexibility theory" seemed to explain the match between the technology of hypermedia and the manner in which we best learn complex subject material. "Basically, the theory posits that in order to learn complex material,

the learner has to see that same material at different times, in different situations, for different purposes and from different perspectives" (p. 7). When hypermedia links together related pieces of information in meaningful ways, it has similar properties to the cognitive flexibility theory - "the ability to see different aspects of a complex subject area from different perspectives in different contexts" (Borsook and Higginbotham-Wheat, 1992, p.7). While further research is required to explain exactly how the brain deals with complex subject matter, hypermedia may be a way to effectively and efficiently teach complex, subjects with many interconnected elements.

The brain does not work in a linear fashion, like a movie. There are endless connections from both verbal and nonverbal associations with each new piece of information that we encounter. Obviously there are many different theories related to intelligence, thinking and learning. It seems however, that the non-linear nature of multimedia can allow the learner to explore the new material in a way that Borsook and Higginbotham-Wheat (1992) suggest is closer to the way we learn.

Teachers, Technology and Professional Development

Larry Cuban has written widely about the use of technology in reform movements in schools. Many of the early efforts were unsuccessful because teachers were poorly prepared to use the technology, given inadequate support and often the technology was unreliable (Cuban, 1986; Tyack and Cuban, 1995). The attempts to integrate technology into the curriculum many times failed to meet the needs of the teachers, as a

result the technology was not used by the teachers (Glennan and Melmed, 1996).

Glennan and Melmed (1996), in looking at the use and effectiveness of educational technology in schools concluded that it is difficult to assess the impact of instructional technology (multimedia included) because the outcomes are highly dependent on the quality of the entire instructional process. The technology is only a component of a broader instructional activity. However, citing a number of school case histories and statistics from Quality Education Data, Inc.(1994), Glennan and Melmed suggested that there are a number of technology-rich schools that are effectively using instructional technology for improving teaching and learning in exciting and successful ways.

In order to implement new technologies and applications in the learning environment teachers need to have the appropriate instruction in the use of the hardware and software as well as time to develop their instructional materials. As there is a greater availability of good multimedia material the resistance amongst educators decreases and they develop a new excitement for teaching and learning. However, staff development is a growing issue, as instructional applications become more complex and faculty members have little training in the use multimedia, graphics, and animation. It is difficult to create meaningful instructional materials without appropriate training (Charp, 1995; Jackson, 1996). To facilitate this, faculty must be given adequate time within the work day or on an extended contract to develop new materials.

Nishinosono (1991) writes about technology and experiences in instructional design and the teacher's readiness to accept technology as a tool to use in the classroom. With over a decade of observation of instructional process Nishinosono observed that teacher education does not provide appropriate learning experiences to prepare teachers to design instruction which will effectively utilize the classrooms equipped with what he called new information technologies. Traditionally when writing lesson plans, the teacher described the educational intentions, the expected outcomes and behavioral objectives, and listed the teaching activities in the classroom. "In the self-learning environment, teachers are expected to be facilitators or promoters of learning" (Nishinosono, 1991, p.33).

There is of course, widespread support among educators for professional development designed specifically for teachers to support the use of instructional technologies. However, in many cases effectively integrating technology into the classroom requires changes in teachers' instructional behaviors. Unless support is provided for teachers to adapt to new and nontraditional models of teaching/learning excellent curricula can fail. Professional development efforts will have a higher degree of success when there is ongoing support aimed to help teachers adapt their instructional methods from memorization of facts to mastery of thinking skills and knowledge and toward inquiry-oriented learning (Dwyer, Ringstaff, & Sandholtz, 1991; Fontana and Dede, 1993; Havelock, 1973). In order to have success in improving the critical thinking skills of students, teachers need to integrate higher level

cognitive activities into their instructional activities (Fontana and Dede, 1993).

While the focus here is on improving teachers' skills in creating new learning environments it must be noted that without the commitment and dedication of the school administration technological change is slow to mature in the schools. Administrators need to provide supportive environments for change and encourage or perhaps require their staff to participate in training (Fontana and Dede, 1993).

Students and Multimedia

The reward in this study was in reading the many success stories and positive outcomes when multimedia was used to enhance learning. In reviewing a dozen studies of drill and practice computer-based instructional programs Kulik (1994) concluded that programs of computer-based instruction had a positive record. According to Kulik, when students received computer-based instruction they usually learned more, learned their lessons in less time, liked their classes more, and developed more positive attitudes toward computers. Relan and Smith (1996) have observed that hypermedia was perceived as a friendly environment even by students with little or no previous contact. They noted in their observations that the transition from traditional classroom lecture and testing methods was generally positive and did not appear to have frustrated the students.

Miketta and Ludford (1995) developed an interactive courseware template to supplement existing in-class presentations by integrating

into classroom teaching multimedia elements to be controlled by the instructor. Converting lecture notes into a multimedia presentation, adding graphics and links to slides and other resources transformed a classroom full of passive learners "into a room full of active critical thinkers who probed for additional insights" Miketta and Ludford (1995, p.62). The instructors' classroom teaching was improved by giving them better tools, which enabled them to provide more interesting and innovative materials to their students. While it doesn't appear that Miketta and Ludford validated their assessment with control groups, they report that compared to previous classes:

> Test and quiz scores are up by a full seven percentage points, thus we are doing something right in the areas of retention, comprehension, and ultimately, student success. Students get more involved in the lectures and achieve a better understanding of the material when it is presented in a multimedia format (p.64).

Miketta and Ludford (1995) presented real-life experiences in real teaching environments. Reporting that instructors had a renewed interest and enthusiasm for their teaching brought new life and a whole new dimension to an old class by utilizing interactive multimedia technologies. But the real benefit was their observation that students had an increased motivation generated by the more interesting materials.

One must be careful when designing instructional media to be sure that the techniques and elements used are applied for specific learning purposes and do not become gimmicks which may distract the learner (Haugen, 1991). An important instructional message can easily be lost in

a multimedia instructional unit with inappropriate use of sound, motion, graphics, and colors.

Ethical questions can always be raised when there are students in a control group and trial group and their scores on tests and activities are counted toward their grade in the course. However, in an experimental study investigating the effects of interactive video instruction (IVI) students using the new instructional module achieved significantly higher recall and test scores than students in the control group (Cronin, 1993). "The most important outcome of these studies is the preliminary empirical documentation of the effectiveness of interactive multimedia instruction in teaching oral communication skills" (Cronin, 1993, p.8).

Multimedia technologies integrated into the curriculum can involve and promote learning across many curriculum areas. In a collaborative group activity in a multimedia presentations course students explore the factors that contribute to successful multimedia design, review a working presentation and work on effective writing. In well-designed group activities such as this, the students learn from each other and develop higher order thinking skills (Jackson, 1996).

Involving students in multimedia authoring to complete their class assignments was way to promote interactive multisensory learning. In creating multimedia projects students learned research and presentation skills as well as learning to work together in a group (Gardner, B., 1995). As noted previously, "Multimedia can enable an accelerated learning process by combining the logical, linear and verbal left-brain

hemisphere with the visual, creative and abstract right hemisphere" (Wood, 1995, p.21). A ninth grader, commenting about his multimedia experiences said that he enjoyed using computers and actually creating multimedia presentations much more than writing papers. The multimedia projects helped students learn more, increased concentration and involvement in the learning activity. (Gardner, B., 1995, p.56).

Multimedia technologies can also help to develop higher-order thinking skills. They cater to multiple learning styles, student motivation, and collaborative inquiry with links to other information and multiple stimuli (Fontana and Dede, 1993) Research has shown that when students were engaged in "authentic" learning tasks they better retained what they had learned. When an individual or a small group of students carried out real world projects using the computer they developed their cooperative skills, communication skills, and showed an improvement in subject matter learning (Glennan & Melmad, 1996).

CHAPTER 3

Analysis and Discussion

There are many differences between traditional educational materials and multimedia materials. The technology alone for the creation of multimedia learning environments, compared to books or even films and videotapes is a complex and expensive process (National Education Association, 1994; Tuttle, 1991). The high cost and short useful life of multimedia workstations has been somewhat limiting in the widespread adoption of multimedia systems. Tuttle (1991) suggested, that a revolution must take place in order for delivery system technology to reach the masses. Perhaps this revolution is taking place now. At the turn of the decade it was difficult to speculate on the explosion of home computer sales, the CD-ROM as a standard feature in every computer, or the popularity and ease of access of the Internet and World Wide Web. In a National Education Association survey (1994), roughly one fourth of all teachers surveyed indicated that they used multimedia software in their classrooms. That number must be exponentially higher today. "Technology is only a component of an instructional activity. Assessments of the impact of technology are really assessments of instructional processes enabled by technology, and the outcomes are highly dependent on the quality of the implementation of the entire instructional process" (Glennan & Melmad, 1996, p.19).

Well designed multimedia materials can teach to multiple learning styles. They can encourage the student to explore at his or her own pace, to jump ahead, repeat a section or to branch to related material.

Students with different learning styles (such as visual or auditory learners) can the access information that helps them to best understand the material. The students may use text, graphics, audio, and video information, will have the ability to self-assess their level of understanding and based on scores branch back to review or jump ahead to new material. The students can individually interact with the program and make choices about which path to follow. It is possible that no two students will follow exactly the same path to complete an assignment, and yet each will better understand the material, beyond what they may have absorbed by reading the book or listening to a lecture (National Education Association, 1994; Wood, 1995)

The use of multimedia authoring by students in the learning environment provides "multisensory" learning experiences that are unparalleled in education. Authentic learning activities incorporating real-life issues that encourage collaborative effort have been quite successful. The student develops thinking skills and actively seeks knowledge. Because technology not only enhances thinking skills and strategies, but has a long-term impact, students are better prepared to perform in a variety of functions when they are back in the real world and away from the technology (Clemens, 1996).

"The best role for multimedia in schools is not to augment data delivery in conventional instruction, but instead to foster a new model of teaching/learning based on learners' navigation and creation of knowledge webs through a formal inquiry process (Fontana and Dede, 1993, p.2)

Conclusion

There have been notable studies into the effectiveness and student outcomes related to computer assisted/aided instruction, hypertext, hypermedia, interactive multimedia and the psychology of multimedia. There is a mountain of work written about the subjects, and much analytical academic discourse. While it is challenging to add a significant insight to the previous work it has been interesting to observe how many different approaches to the subjects yield similar conclusions.

Up to this point in this review there has been little mention of the Internet as a multimedia resource. It is interesting to note the progression of the terms "computer assisted" or "computer aided instruction", "hypertext", "hypermedia", "multimedia", "Internet", "World Wide Web" (Web), "HTML", and "URL" as they appear in publications over the last few years. There are very few references to the Internet in educational journals or Ed Media magazines prior to 1994. Gradually in 1994 and early 1995 the terms, articles and papers began to ease into professional reading. 1995-1996 saw an Internet and Web explosion in virtually every consumer, trade, and professional publication and journal. The Internet will play a key role in education. While not presented as a structured, programmed instructional system, the World Wide Web embodies all of the elements of instructional media that have been previously discussed. Links from one Web page to another are primarily in the form of hypertext. The Web integrates text, graphics,

still photos, animation, audio clips, and video clips with an interactive user interface (the computer and keyboard) linking to unlimited information resources worldwide, making the Web the largest "multimedia" application in existence. While browsing the Web one may often cross the line, back and forth, between fact and fiction, or between meaningful instructional materials, reference material, entertainment and junk.

With the exception of the linking to external information resources the above elements are also found in most contemporary computer and video games. These computer and video games may not fulfill a specific learning objective, but they are certainly multimedia applications that are influencing young people. Younger students, still developing their reading and learning skills, and having been exposed to the fast-paced, fast-action of computer and video games, can become frustrated with the slow access times of the Web (sometimes called the World Wide Wait) and the predominance of text-based information, which requires them to read the words rather than interacting with the visuals. The instructor then, is challenged in structuring learning activities that take advantage of the novelty and power of the Web to provide direction and paths to age appropriate resources that will stimulate and engage the learner as well as fulfilling the instructional objectives of the unit being studied.

The future of multimedia in education will likely continue to grow. Many years ago Thomas Edison predicted that the movie projector would replace books (Cuban, 1986). Obviously that has not happened, but

the movie projector became an important instructional resource. Likewise, the digital medium will not replace books, or other visual or audio media, but it will transform the way in which they are used for educational purposes (Noblitt, 1995). Whether being used for drill and practice, to introduce new concepts, to search for information, to allow students to progress at their own pace, or to stimulate creativity and learning, the use of multimedia technologies is here to stay. The decreased student-to-computer ratio in the schools as well as the increase of use of CD-ROM and laser disc technologies and access to the Internet provide the tools and the media to stimulate the imagination of students, making learning interactive and exciting. One insightful student involved in multimedia authoring to make a report for a class, sums it up well by saying,

> As our society advances, it relies less on text and more on visual communication. I think it's an important part of education to learn how to make these visual presentations, because these visual skills are going to be so important in the future - not just in school, but also on the job (Gardner, B., 1995, p.56).

The progressive teacher knows the importance of quality instructional design and will look for every opportunity to integrate appropriate multimedia into the learning environment - to help students develop new skills and to excel.

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