REVIEW OF LITERATURE

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The purpose of this review of literature is to examine current reports of multimedia's utilization of educational hardware and software to assist concept attainment in classroom instruction. Before exploring multimedia's influence on concept attainment, or student learning, it is important first to define the terms *multimedia* and *concept attainment*. Second, the relationship of learning styles, cognitive styles, and theories of cognition will be discussed. Third, the methods in which designers use these theories to blend multimedia's capabilities to enhance concept attainment in instructional software will be examined. Fourth, recent empirical studies will discuss multimedia's effectiveness in the classroom. Finally, future research issues concerning multimedia's applications in educational materials will be summarized.

DEFINITION OF TERMS

At one time in educational history, the term *multimedia* simply referred to as a presentation that combined a form of video, such as a slide show or a series of overhead transparencies with sound effects, such as music or narration. With instructional technology's rapid advancement, the term has evolved from that embryonic state into a new technological creature. Because of its different definitions during its lifetime, it is important to define its current "state of being" in education.

"Multimedia brings together video, graphics, animation, text, and sound in a single, computer-controlled presentation. Elements are stored and processed digitally for greater flexibility in importing and moving information" (Magel, 1990, p. 65). "Multimedia is a method of designing and integrating computer technologies on a single platform that enables the end-user to input, create, manipulate and output text, graphics, audio, and video, utilizing a single interface" (Strothman, 1991).

> The definitions of today generally share one thing in common . . . all seem to view multimedia as the combination of two or more media and imply or assume interactivity via computer . . . Others dislike the term *multimedia* altogether, as it is too often associated strictly with PC-based systems as opposed to Apple-DOS systems. Suffice it to say, *multimedia in the 1990s usually will be referred to as still or motion video, text graphics, audio, and animation controlled by a computer* . . . It is a combination of hardware, software, and storage technologies incorporated to provide multisensory information environment (Galbreath, 1992, p. 15).

It is important at this point to differentiate between *multimedia* and *hypermedia*. Hypermedia applications advance technology a step further than multimedia and actively engage readers in an *extensive* medium that allows them to move through "a surface text that provides a starting point and links which lead the reader away to browse among many diverse topics . . . . or the document could be considered an *intensive* medium with links providing supplemental information to help the user read and understand the original text" (Hillinger, 1994, p. 32). In other words, multimedia is the engine that drives the hypertext document.

Another major difference between multimedia and hypermedia lies in the user's cognitive operations. For example, in multimedia software design, the students use the various functions to recreate the learning that was intended by the instructional designer. The learners travel a preselected trail to concept attainment and are rewarded at journey's end with colorful graphics, positive reinforcement through sound, scores, or complimentary text. In these educational materials, users must move on a linear avenue to mastery of the specified learning objective.

However, in hypermedia environments, students exercise choice and control of their personal learning. Students may be assigned a general global activity, such as writing a report about a German composer using Microsoft's *Encarta* or *Compton's Interactive Encyclopedia (CIE).* Because of the hypermedia capabilities of these multimedia encyclopedias, some students might write a report using sound clips from the software. Others might print graphics, such as musician's portraits, or biographical sketches in order to complete their projects. Exactly what information was selected and used from the software would not be important.

What is significant is that the students could complete their assignment in more than one way. In other words, they have demonstrated mastery of the concept of "technology" by individual control of the learning environment. The students have attained the desired concept by browsing through the landscape of information presented in the hypermedia program and produced a unique product that demonstrated understanding (Caverly & Broderick, 1990).

Still, in its own right, multimedia must be acknowledged as a worthy method of instruction for certain students. "Multimedia technologies have a great potential to empower learners' mastery of higher-order thinking skills. The leverage that sophisticated multimedia provides stems from a synthesis of multiple attributes rather than any single characteristic: learning via structured discovery; ability to tap multiple learning styles; web-like representations of knowledge; enhanced mastery through learner authoring of materials; the collection of rich evaluative information; and technology-supported collaborative inquiry" (Dede, 1992). Multimedia's strengths lie in teaching students how to think like the designer/teacher, but its opportunities for student's original creativity are limited.

RELATIONSHIP OF PROMINENT THEORIES OF COGNITION, LEARNING STYLES, AND COGNITIVE STYLES

Education's past history of falling victim to learning fads speaks for itself. On many classroom closet shelves sit the at-one-time fashionable controlled reading machines, language masters, and sequenced learning kits. Before endorsing multimedia software as a viable instructional tool, it is important to review how prominent theories of cognition either support the capabilities of multimedia software or refute it as a trendy media.

Many cognitive theories explaining human learning are rooted on the work of Jean Piaget, a Swiss psychologist. In general, Piaget believed that intellectual growth from childhood to adulthood occurred in four distinct stages that are in a fixed order. Even though the succession of stages are largely irreversible and permanent, the rate of development can vary from one individual to another. As a result some children advance quickly through these stages while others move at a slower pace; but, no matter what the cognitive pace, the sequential order of the stages did not vary.

During this time a contemporary psychologist in Russia, Lev Vygotsky also was studying children's cognitive development. He disagreed with Piaget's theories of sequential developmental stages because the element of the learners' interactions with their social environment was totally discounted.

In contradiction of Piaget's thoughts concerning linear irreversible stages of cognitive development, Vygotsky argued that humans move easily between developmental cognitive stages when engaging in problem solving processes as they approach maturity. Often these stages are revisited to activate a previously learned cognitive strategy.

Vygotsky also challenged Piaget's developmental stage theory of cognition. In his studies, he did not consider differences between adults or children when determining how the learning process occurred; he studied all learners. The well-known "zone of proximal development" was oblivious to age or life experience. Vygotsky believed in the *scaffolding* approach. Here through social interaction, the teacher provided appropriate support to the students as they were led to the edge of old, familiar knowledge in one concept and then made cognitive leaps into new frontiers of knowledge (Kozulin, 1988).

Vygotsky viewed social interaction as an avenue of easing learners into their zones of individual proximal development which, in turn, ignited the internalization process of active learning. He believed that the phenomenon of one learner working with another to be more competent than one learner working alone to generate new knowledge (Lemerise, 1993). This philosophy matches the current theories of cooperative and collaborative learning.

As teachers change roles from presenters of information to facilitators of learning, multimedia gives students tools or avenues for effective learning as well as experience in using technology (Ely, 1990). With this educational restructuring and introduction of multimedia programs into the classroom, many teachers have seized the opportunity of shifting this responsibility for learning in a manner that has led to the empowerment of learners at all levels.

Howard Gardner, Professor at the Harvard Graduate School of Education, believes that the human mind and the natural patterns of learning are ill-suited to traditional educational materials, practices and institutions. His theory of multiple intelligences presents three kinds of knowledge which span across the disciplines. Within this threefold framework lay seven forms of intelligences from which humans come to know the world. These include intellectual processes to understand life through linguistic translations, logical-mathematical analysis, spacial representations, musical thinking, bodily-kinesthetic methods of problem solving, interpersonal relationships, and interpersonal knowledge (Gardner, 1989). “It seems clear that all schools could benefit by understanding this theory . . . . its implications for individual students . . . and the guidance in finding appropriate educational uses for computers” (McCahill, 1994, p. 250).

John Dewey’s definition of inquiry is “the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinction and relations as to convert the elements of the original situation into a unified whole” (Dewey, 1938, p. 104). In computer simulations, a problematic situation drives the learning. Students move through an experience accessing information and building new cognitive relationships to work toward a solution. Dewey located technology in the heart of inquiry. He viewed inquiry as a productive craft and technology as the tools of the craft. His definition of technology might include hammers, symbols, languages, and any ideas necessary to locate the source of a problematic situation and project resolution (Roschelle, 1994). In accordance with Dewey’s thoughts, the use of computers and multimedia software are the tools that students utilize in the process of constructing their own learning.

Other cognitive studies of learning theory have expanded the basic Piaget, Vygotsky, Gardner, and Dewey philosophies. Witkin's learning style theories emerged in the 1950's. He distinguished field dependent learners, who rely more on external references to process new information, from the field independent learners who rely on internal references to assimilate knowledge. Kolb (1976) developed a four stage model, based on theoretical background of experiential learning, that described four kinds of abilities to be an effective learner—"concrete experience (CE), reflective observation (RO), active experimentation (AE), and abstract conceptualization (AC), which formed opposing ends of two separate dimensions abstract/concrete and active/reflective (Ayersman, 1993). Numerous learning styles inventories, such as Kolb (LSI) *Learning Instructional Styles Inventory* (1976); Canfield's *Learning Instructional Styles Inventory* (1980), which measure the multidimensional aspects of both the student's learning style as well as the teacher's instructional style, and the *Myer-Briggs Type Indicator* (1992) appeared. These inventories address 16 types of learning styles outlined in Jungian theory which explain extroversion, introversion, sensing perception and intuitive perception, thinking judgment and feeling judgment (Ayersman, 1993).

Modality-based research examines environmental effects on students as they learn. Ehrman (1990) studied the lighting conditions of the room, the desirable temperature conditions, food and drink intake, and the use of visual or acoustical aids. The Dunn, Dunn, and Price (1985) studies examined student reactions to 23 separate elements concerning information integration. These elements can be categorized as environmental, emotional, interpersonal, physical and cognitive. Dunn (1988) further researched the psychological and cognitive areas in 1988 focusing on global/analytic, impulsive/reflective, and hemispheric style of learning (Ayersman, 1993).

Cognitive psychologists have contributed much to both the field of learning and the development of artificial intelligence applications in educational multimedia technology. As more is learned about human cognitive development, it is easy to understand that traditional teaching materials and methods must simultaneously evolve to meet the growing challenge of stimulating learning.

BLENDING MULTIMEDIA'S CAPABILITIES TO ENHANCE CONCEPT ATTAINMENT

Presently, educators are bombarded with thousands of stand-alone instructional programs that are produced by increasing numbers of software publishers. For example, in 1988 there were over 10,000 stand-alone products produced by about 900 software vendors. At least a dozen major manufacturers also specialize in elaborate integrated learning systems (ILSs) that span large segments of the elementary and secondary curriculum. Overall, most of the software's technical quality is quite good, but there is a general consensus that most packages do not yet sufficiently exploit the capacity of the computer to enhance teaching and learning (Power On, p. 122).

By 1991, 70 percent of teachers who had access to video resources, as reported in a NEA survey, reported using them regularly. About sixty percent of the teachers with access to personal computers, as reported in the same survey, use the multimedia software on a regular basis (Teachers and Technology: Making the Connection, p. 92).

Computer programs with multimedia accouterments appear in stand-alone as well as in the ILS format. Some multimedia software packages claim to be *interactive* programs. Again, the degree of interactivity in a program can range from simply clicking on a forward button or typing a correct response to having total control in a nonlinear environment.

In the stand-alone programs, concept attainment is reinforced with software designed in game, simulation, or problem-solving format. Teachers choose specific packages to support a textbook unit and to provide different media of instruction.

Older versions of integrated learning systems, on the other hand, have a different purpose. Instead of supporting concept attainment, the older packages may have actually supplanted the curriculum. These linear modules may be decorated with multimedia capabilities, but their primary purpose is to instruct or reinforce the user in a specific skill. Manufacturers claim that the package offers individualized instruction and personalized monitoring of student mastery; however, ILS's primary function is to assist school districts in raising test scores on skill specific tasks. Here, the teachers' short term goal is to teach specific skills in reading (i.e., identifying the main idea, detecting sequence, recognizing author's tone), math (i.e., addition, multiplication, statement problems), language arts (i.e., punctuation, parts of speech, sentence structure) instead of creating original thinking. Success is determined by comparing pretest and posttest scores from publisher-designed assessment tools, standardized subject content area tests, or researcher designed measures.

Each type of multimedia software serves a different educational purpose. Educators must match the type of instruction that best suits student needs. If multimedia enhanced software is appropriately utilized in education, the classroom can become an exciting place; if the computer activities are used to fill excess time on Friday afternoons, the educational possibilities suddenly evolve into an artificial childcare device.

For most school districts it is difficult to justify the costs of acquiring and implementing innovative programs unless the software genuinely improves conventional teaching methods. Software must be purposely selected to assure educational value to both to the student and the public who supports the school systems with its moneys (Power On, 1988). For this reason, initiatives such as The Educational Software Selector (TESS) have been provided to Texas educators.

MULTIMEDIA'S EFFECTIVENESS IN THE CLASSROOM

Much of the research concerning computer effectiveness in classroom instruction comes from the publishers themselves (Reinking, 1991). In the educational field, a reader will find great controversy between the results of empirical studies comparing traditional instruction and technology-supported instruction. It is justifiable to say that on the average, fifty percent of the studies' findings will claim a significant improvement in student performance while the other fifty percent will show that there was no significant difference between the performance of the subject groups.

Results sometimes seem contradictory, but that is due to the complexity of the questions. Explanations of improved student performance include the Hawthorne Effect or the novelty of the technology in the classroom, peer collaboration, increased student motivation, having computers located within the classroom instead of a lab located in another part building, teacher's enthusiasm and ability in the technological environment. Reasons for student non-performance include the teacher's lack of computer literacy, students' unfamiliarity with the courseware, lack of student motivation, less than three hours of computer activities weekly, excessive use of drill and skill software, or continuous technical difficulties.

Comparing traditional instruction with computerized instruction, as was done in the 1960s and 1970s, is not the best approach. The relevant question is what technology works for which students in specific situations. For example, incorporating multimedia support into daily instruction would provide information useful to teachers. Specifically, in a recent study examining the performance of preschool children in a comprehensive computer curriculum, posttest scores presented evidence that the premath knowledge and comprehension monitoring can be enhanced using CAI and Logo software (Howard, 1994). By employing the strengths of sound teaching practice and the delivery of multimedia instruction, concept attainment is enhanced.

Integrated Learning Systems (ILS) fill the instructional needs of some children. By providing multiple opportunities for practicing a specific skill, patient tutoring encourages the student through the learning process until mastery is achieved. However, the ILS's long term goal is to improve student's test-taking abilities so that performance on the post tests or state mandated competency tests will reflect progress (Stahl, 1992).

ILSs do have limitations. One study designed to instruct and model effective reading strategies to 205 undergraduates for college-level biology and psychology texts found transfer of study skills from an interactive computer program to printed text in a traditional classroom to be significantly better than transfer of study skills from a drill/skill tutorial computer program to text in a traditional classroom. Study strategies, instead of sequential modules concentrating on content area specific drills, significantly influenced student behavior (Mikulecky, 1988). Strategy transfer occurs more naturally when students have opportunities to practice the newly learned strategies on their own texts. They become effective independent learners when they can control strategies that enhance learning (Stahl, 1992).

Computer assisted instruction (CAI) has demonstrated significant improvement in most studies with posttests in terms of achievement and student attitude toward computers; however, there seems to be the inability for students to transfer any isolated skill instruction from the ILS environment to traditional classrooms (Caverly, 1994; Mikulecky, 1988). In some studies of reading achievement, there was no difference in reading performance when instruction was presented through drill/skill and tutorial format or printed text in a traditional environment (Balajthy, 1985; Feeley, 1986; Wepner, 1989).

FUTURE RESEARCH ISSUES IN MULTIMEDIA APPLICATIONS AND CONCEPT ATTAINMENT

It is difficult to anticipate what new and unique effects multimedia will have on classroom instruction. The courseware/hardware changes as quickly as knowledge of cognitive growth expands. However, teachers owe their students the responsibility of staying vigilant as knowledge explodes minute by minute. Teachers, knowledgeable in the assets of technological instruction, can encourage student's interaction with electronic media by designing tasks that are both challenging and meaningful. Reliance on multimedia applications alone will not bring about innovational change in teaching and learning; only teachers can reevaluate, renew, and revitalize their classrooms (Zorfass, 1993).

In the future emerging with a firm foundation of multimedia, hypermedia probably will exceed multimedia's capabilities in concept attainment (White, 1991). In addition, it will be able to offer performance-based assessment projects that can include multiple solutions, active student engagement, replication of real world experience, cooperative learning situations, and integration of content area knowledge. Performance will depend upon effort of the learner (Baugh, 1994).

Teachers of the 21st century can expect hypermedia classroom instruction to evolve into Virtual Reality. The technological innovation establishes a new contact between humans and computers in which three-dimensional representation can be reconstituted to create any desired experience. Students can visualize a situation and experience it safely in a multimedia environment (Dede, 1992). Virtual Reality's use in the educational classroom is only limited by the educator's imagination.