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The effect of teacher scaffolding and student comprehension monitoring on a multimedia/interactive videodisc science lesson for second graders

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THE EFFECT OF TEACHER SCAFFOLDING AND STUDENT COMPREHENSION MONITORING ON A MULTIMEDIA/INTERACTIVE VIDEODISC SCIENCE LESSON FOR SECOND GRADERS

by

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Imagery based computer instruction is predicted to have a major impact on educational curriculum in the next century. Yet research on the effectiveness of imagery technology for early elementary-age children is a relatively unexplored area. The purpose of this study was to examine age-appropriate uses of a multimedia/interactive videodisc (IVD) science lesson for second graders in two areas. First, the unique properties that these media offer as a stand-alone teaching tool were assessed. Second, the non-technological strategies of teacher scaffolding and comprehension monitoring as supplements to IVD programs were investigated. A learner controlled multimedia/IVD instructional program was specifically designed for this study. The learning objectives were to teach the scientific processes of classification and problem solving through observing, comparing, and contrasting two species of primates: apes and monkeys.

Sixty second grade students from a public school system were administered one of four levels of treatment: the IVD lesson only, comprehension monitoring only, teacher scaffolding only, and teacher scaffolding with comprehension monitoring. The children in the comprehension monitoring groups were taught to use four questions while navigating

each of the constructs in the multimedia/IVD lesson. The teachers in the scaffolding groups used an open-ended script which included modeling, explaining the subject or process being taught, and questioning.

An analysis of covariance (ANCOVA) was conducted on the adjusted dependent measure. The independent variable was the treatment level. The dependent measure was the posttest knowledge score on a 25 item multiple choice test. The covariate was the pretest knowledge score. The IVD lesson only group registered significantly higher adjusted knowledge test scores after controlling for preexisting differences. The comprehension monitoring only and teacher scaffolding only groups recorded significantly higher test scores when compared to the IVD lesson only group. The teacher scaffolding with comprehension monitoring group made statistically higher scores when compared to each of the other three treatments. However, no significant group difference was registered between the teacher scaffolding only and the comprehension monitoring only groups. Possible explanations for these findings are discussed and recommendations for future research suggested.

CHAPTER I

BACKGROUND

Computer based instruction for young children is a topic characterized by controversy and paradox. Heralded as a majestically beneficial tool, this technology has been described as having the power to transform our schools and revolutionize our educational system (Lepper & Gurtner, 1989). Proponents describe the computer as the ultimate tutor. Programs with multiple imagery formats have been designed for every academic discipline. These applications can guide students at their own speed through complex problems with unlimited remediation. In this context, the computer is acclaimed as a patient, nonjudgmental, and supportive mentor (Smith & Sherwood, 1976; Dede, 1986).

Opponents have criticized adding computers to the world of young children as developmentally inappropriate and dehumanizing (Sloan, 1986). Detractors argue that elementary-age children may not be ready to process the wide range of information which could flow from the mixture of video and text (Miller, 1990). These skeptics also suggest that placing educational technology in a classroom could eliminate critical social interactions with teachers and other students. In this scenario, the computer is viewed as a substitute babysitter for television into which the child would be passively plugged day after day (Lepper & Gurtner, 1989).

Advocates of the computer as the ultimate tutor support their position by citing the versatility of imagery system applications and the positive learning outcomes from research studies (Bosco, 1986; Evans, 1985; Hannafin; 1985; Lepper & Gurtner, 1989). Pioneering multimedia/interactive videodisc (IVD) programs from Stanford, Harvard, and the Pratt Institute are often used to demonstrate the enormous potential of this technology. Stanford University's "The Shakespeare Project" has several versions of "Hamlet". Students can analyze dozens of theatrical approaches by choosing from hundreds of set designs, costumes, and props to create their own versions of the play on a digital stage. The entire script is written on the screen while the play is shown on the videodisc monitor (Friedlander, 1988). Harvard University's classics department developed an interactive curriculum on Greek civilization. These lessons include a historical atlas of the Persian Wars, the text of the Greek tragedies, and an archaeological database (Crane, 1988) The Pratt Institute's acclaimed imagery program is an interactive videodisc and CD-ROM version of the book, Interaction of Color, by Josef Albers. Students can view plates from the book as well as create their own versions of the reproductions, drawing from a potential of 16 million colors (Phelan, 1988). More recent multimedia/IVD projects include foreign language programs in Hebrew and Chinese at the

University of Michigan, civil war videodiscs at Mason University in Virginia, an English literature program at Brown, a teaching strategies program at Indiana University, a health care videodisc program at the University of Texas, and law videodiscs at Harvard (Nelson & Palumbo, 1992). On the middle and high school levels, multimedia/IVD programs have been designed for such diverse areas as biology, earth sciences, economics, chemistry, geography, mathematics, and psychology (Bunderson, 1983; Cassidy, 1985; Dalton & Hannafin, 1987; Glenn, Kozen & Pollack, 1984; Hannafin & Colamaio, 1987; Russell, Staskun & Mitchell, 1985; Thorkildsen & Friedman, 1984).

Research studies have indicated the effectiveness of imagery applications for secondary and postsecondary students, registering consistently small, but positive learning outcomes (Bosco, 1986; Cassidy, 1985; Evans, 1985; Dalton & Hannafin, 1987; Glenn et al., 1984; Hannafin & Colamaio, 1987; Russell et al., 1985; Thorkildsen & Friedman, 1984). Investigators report that this technology is thought to enable the student to integrate subject material on a deeper level, and understand more through making a higher number of connections among concepts (Anderson & Reder, 1979; Borkland, 1989; Nelson & Palumbo, 1992; Salomon, 1983). Students scored higher test gains using multimedia/IVD programs when compared to traditional classroom lecture presentations of the same material (Browning, White, Nave, & Barkin, 1986; Glenn et al., 1984;

Hannafin, 1985; Hasselbring, et al., 1987; Russell et al., 1985). Statistically significant increases in pre-to-posttest learning also have been reported (Bosco, 1986; Cassidy, 1985; Evans, 1985; Dalton & Hannafin, 1987; Glenn et al., 1984; Hannafin & Colamaio, 1987; Russell et al., 1985; Thorkildsen & Friedman, 1984). Computer advocates claim with certainty that multimedia/IVD technology will produce the same educational benefits for younger children as it has for this older population.

Computer opponents do not dispute the utility of IVD technology nor the research findings. Their argument focuses on the differences in cognitive development between older and younger children and the lack of research on elementary age populations. These skeptics respond that findings for older children can not be generalized to early elementary age students as older children have different cognitive capabilities. Four major differences have been identified (Bjorklund, 1989; Bjorklund et al., 1990). First, older children can process information faster. Faster processing helps these children focus on relevant information as they can more easily construct frameworks on which to place their new knowledge. Second, older children have strategies to use in processing new information which younger children do not. Third, older children know more about their memory processes. These students can more deliberately remember new information and, then, monitor their own progress. Finally, older children have more knowledge about specific subjects.

Integrating new information is faster for these students since the more familiar words or ideas are, the more easily remembered they are. For younger children, the problem is further exacerbated as the access modes in multimedia/IVD programs are continually expanding to accommodate more open and flexible use of large bodies of information (Gay, Trumbull, & Mazur, 1991). Thus, multimedia/IVD could be a form that is too free of structure for early elementary-age children. From a developmental standpoint, detractors view the computer as a menacing device which could decrease rather than increase educational opportunities for young children.

Although both sides passionately continue this debate, educational governing bodies already have identified computer based instruction as a critical component of the educational system for the future. The National School Boards Association, Carnegie Commission, and the National Task Force on Educational Technology determined that the nations' schools must adopt a technology based curriculum in order to increase educational productivity (Congress of the U.S. Office of Technology Assessment, 1990; Kinnaman, 1989; National School Boards Association, 1988). With the current technological advances in reducing the size of equipment and increasing the speed of processing, a 21st century school is predicted to be one in which each student is provided with a portable computer with multiple imagery system capabilities (Lepper & Gurtner, 1989). Given that computer based instruction (CBI) could be an integral part of the educational system, our task is to understand the ways this technology can be used to provide positive educational experiences for the young child.

Statement of the Problem

In order to learn more about the kinds of multimedia/IVD experiences that contribute to positive learning outcomes for young children, four research questions were examined. The first question was designed to investigate the effectiveness of a multimedia/IVD lesson as an instructional tool for second grade children. Whether or not a medium's capabilities make a difference in learning depends on (1) how the components and presentation correspond to a particular learning situation, i.e., the tasks and learners involved, and (2) the way the medium's capabilities are used by the instructional design (Kozma, 1991). With the instructional effectiveness or motivational appeal of multimedia/IVD often depending on the use of flashy inputs of sound, color animation, and reels of video, researchers have necessarily speculated about the depth of initial student learning. Instructional programs exist which provide a multitude of tools for accessing elaborate tutorials with complex feedback and remedial systems. However, their existence has not guaranteed their understanding or use by younger children (Sutton, 1991). Research was needed to determine if multimedia/IVD was a media form that was too free of structure for the cognitively immature child.

The second research question was stated in order to examine the contribution of comprehension monitoring as an effective supplemental strategy to multimedia/IVD programs for young children. Researchers have shown that increased involvement in an activity through comprehension monitoring techniques creates both faster and more thorough recall and synthesis in retrieval studies (Flavell, 1979; Flavell, Speer, Green, & August, 1981). Upper elementary children who were taught self-monitoring strategies during instruction were found to have (1) more active involvement, (2) a routine to aid in organizing new content with current knowledge or framework, and (3) a means to maintain and generalize through a trained (learned) strategy (Miller, 1990). The success of this technique is thought to be through providing multiple retrieval routes to the essential information (Anderson & Reder, 1979; Bjorklund, 1989; Nelson & Palumbo, 1992; Salomon, 1983). While research studies suggest that early elementary children do not have a facility to do this spontaneously, they can successfully comprehension monitor when task demands are reduced (Miller, 1990). Thus, young children could learn to monitor their own thinking while navigating through multimedia/IVD lessons.

A third research question was stated in order to test whether teacher scaffolding is an effective supplemental strategy to be used with multimedia/IVD programs for young children. Scaffolded instruction is defined as a joint interaction in which the student and teacher share the responsibility for learning (Wood, Bruner, & Ross, 1976). When teacher scaffolding techniques were added to computer curriculum, learning gains have been registered both for preschool and elementary age children (Brinkley & Watson, 1989/90; Easton & Watson, 1990; Fay & Mayer, 1987; Markham, 1981; Miller & Emihovich, 1986; Pea & Kurkland, 1984; Solomon & Perkins, 1987; Nelson, Howard, Ingles, Wheatley-Heckman, Watson, 1988; Watson & Busch, 1989). Research was needed on how this strategy might affect learning outcomes.

The fourth question was designed to test if teacher scaffolding combined with comprehension monitoring was an effective supplemental strategy. Both the strategies of comprehension monitoring and teacher scaffolding are based on increasing students' involvement in the learning process through dialogue (Wood et al., 1976; Vygotsky, 1978). With comprehension monitoring, the dialogue is within the learner only. With scaffolding, the responsibility for generating the dialogue rests with the teacher initially. Once the learner engages interactively with the teacher, the process becomes a reciprocal one. Both strategies enable the learner to create faster and more thorough recall and synthesis as he/she moves from relatively simple to more complex levels of thinking (Bjorklund et al., 1990; Flavell, 1979). How the combination of these two complementary strategies might enhance the learning process using multimedia/IVD lessons was another area for exploration.

Importance of the Study

Multimedia/IVD has been identified by national planning, educational and teaching associations as a critical component of the educational system (Kinnaman, 1989). General agreement exists that the learning process is thought to be most effective when the media, teaching, and learning processes are precisely adjusted to the processes the learner has to carry out (Kozma,1991; Salomon, 1983). However, research does not provide the answers that administrators, teachers or instructional designers need to scientifically guide their efforts in implementing multimedia/IVD curriculum.

Data from the current study make a significant contribution to the literature in three specific ways. First, the data broaden our knowledge base concerning multimedia/IVD as an instructional delivery system for early elementary age students. Given that imagery systems could be an integral part of all educational systems in the future, determining if these systems are an appropriate technology for young children is a significant contribution to be made to the field of human development and educational technology.

Second, the findings provide data with which to evaluate the effectiveness of adult mediation of a child's learning process as proposed in the Vygotskian socio-cognitive development theory. These data also address the Information Processing assumption that a young child may not have the ability to manage the range and depth of inputs that he/she could experience with multimedia/IVD. In addition to the range of stimuli, these data will indicate the effectiveness of comprehension monitoring strategies to aiding the young child's thought process to move from effortful to automatic. Research which helps clarify theoretical perspectives is a key element to the continued growth within the field.

Third, the study reported herein also examines teaching/learning instructional models for use with multimedia/IVD technology. Determining the instructional variables with which young children are taught to monitor their own comprehension is important. Analyses of factors that lead to effective teacher scaffolding also are significant. Answers to such questions will allow human developmentalists, school personnel, and multimedia/IVD design teams to better plan for optimum student academic achievement when incorporating multimedia/IVD technology into existing curriculum.

Theoretical Framework

This research was guided by Vygotskian socio-cognitive development theory and the Information Processing model of cognitive development (Emihovich & Miller, 1986; Harnishfeger & Bjorklund, 1990; Sternberg, 1985; Vygotsky, 1978). Vygotsky held that children process information in the form of social interactions starting with events viewed externally and concluding with symbols manipulated internally. In other words, through social exchange with adults and peers, children learn to use higher mental processes to take in social transactions and process meaningful symbols in their everyday lives. In Vygotskian theory, adults are seen as teachers or mediators who can pace and temper a child's learning process. How events are explained through mediation by teachers are held to be the key parts in guiding a child's learning (Emihovich & Miller, 1986). Scaffolded instruction originated with Lev Vygotsky's "zone of proximal development" defined as:

> the distance between the actual developmental level as determined by independent problem-solving and the level of potential development. The child's level is determined through problem-solving under adult guidance, or in collaboration with more capable peers. (Vygotsky, 1978, p. 86).

Central to designing a scaffolded lesson in the Vygotskian perspective is knowing how to assess and work within the child's current cognitive, emotional, social, and behavioral developmental frameworks.

Knowing how a child's understanding varies within differing areas, yet how all are intricately bound, also has been examined within the information processing model of development. Information processing seeks to explain how a child manages the flood of information which he/she is constantly experiencing (Flavell, 1979; Case; 1985; Bjorklund et al., 1990). This stimulation includes facts about the people, objects and events surrounding them, and their functioning. Information processing, rather than one specific theory, is based on a set of assumptions surrounding how people acquire, store and retrieve information.

Processing is defined as mentally acting on information. The terms which are covered under "mental actions" include operations, procedures, strategies, and information processing components. Each refers to mental actions used to encode or make sense of input, i.e., to think.

Information processing theory assumes that the mind can deal with a finite amount of information at any single time (Bjorklund; 1989; Frankel, 1989; Case; 1985, Harnishfeger & Bjorklund, 1990). Two processes are involved: mental energy to expend and mental space in which to operate. Schematically, models are drawn with interconnecting structural components to illustrate psychological constructs in a child's mind, not the anatomical and physiological design of the child's brain (see Appendix A).

Of the components described in the multi-store model, developmental differences in capacity have been found in the sensory register, and in the short- and long-term stores (Bjorklund, 1989). Sensory memory is thought to be located in the sense organ which holds an unselective form of memory for everything that interacts with a particular organ. The storage of this information is only momentary, lasting only milliseconds for visual stimuli to a couple of seconds for auditory information. During this time, an interchange occurs between the sensory register and short- and long-term memory, and the motivation/attention components. This exchange determines which items represent knowledge of words and familiar concepts in nodes (Collins & Loftus, 1975).

Nodes are linked by features that characterize the item. The closeness of these nodes is through the strength of association between these features. The strength of a connection between nodes is a key element in the thought process. The more highly activated through the sensory registers, the more likely the item is to be entered into the short-term store and become a conscious thought.

The short-term store and motivation/attention components contain numerous factors which, in effect, select the parts of the input for encoding or discarding (Bjorklund, 1989). These two systems also contribute to the way encoded information is interpreted. Developmentally, the short-term store is defined as having the most influence in the early years of life. Pascual-Leone (1976) hypothesized that young children cannot keep two dimensions in mind at once. Thus, they have to shift attention from one dimension to another since they do not have the capacity to coordinate two dimensions's at once. Development occurs as children are increasingly able to consider new strategies which allows them to hold two dimensions in mind. This capacity is the factor which lets them proceed to a new stage (Howe & O'Sullivan, 1990).

A system's available resources are critical in the initial processing pattern. These determine the quality of the interaction between the short- and long-term stores in the use of symbols and other processes in interpreting the input information (Bjorklund, 1989; Bjorklund et al., 1990;

Frankel, 1989; Miller, 1990). After the function of encoding in short-term store, information combines with that already available in long-term store, or knowledge base. This is the permanent store of information that includes our knowledge of the world, past experiences, and strategies that are used to process information and solve problems. The two general types of information contained in the knowledge base are declarative, i.e., facts, and procedural, i.e., information on processes.

Robert Sternberg (1985) proposed the componential theory of information processing. Components are identified in terms of the degree to which they exhibit three properties. First, the amount of time or duration required for a process to be executed is considered. Second, the difficulty, or probability the process will be executed without error, must be determined. Finally, the probability of execution, or likelihood a process will be implemented in a given situation, is weighted. These properties, in turn, determine the attentional resources needed to process and monitor task solution. The probability of execution involves knowledge acquisition processes. Selective encoding, combination, and comparison allow for the identification of information relevant to task completion and for connecting new information to existing stored knowledge.

A motivation component, which until recently has been ignored in these models, falls under the framework of motivation and personality research (Flavell, 1979; Flavell, 1982). The processes involved in the integration of this component with metacognition have been the focus of these investigations. Metacognition refers to one's knowledge about one's own thinking (Weinert and Perlmutter, 1988). Control beliefs and causal attributions are among the factors which regulate the interaction between motivation and other components as input is translated into achievement related actions (Bjorklund, 1989).

Weinert and Perlmutter (1988) suggest that two changes might lead to the acquisition of metacognition. The first change the authors cite is the development of a sense of self as actively controlling one's own thought process. Specifically, these authors identify the development of an internal locus of control as the mechanism which promotes the monitoring and regulation of a child's own cognitive experiences. The second change stated by Weinert and Perlmutter is an increase in "planfulness". This concept involves the interrelation of past, present, and future actions which occur as a result of the acquisition of variations in person, task, and strategy factors.

This process is facilitated through a specific type of metacognition called metamemory. Metamemory is defined as knowledge about one's memory in general (Bjorklund, 1989). This involves functions, such as sensitivity to past experience, with memorizing, storing, and retrieving different types of information in differing situations. Also included in metamemory are the system of skills needed for planning, directing, monitoring, and evaluating one's behavior during learning and remembering. Metamemory provides an explanation for some outcomes and practical suggestions for improving cognitive processes (Howe & O'Sullivan, 1990).

In both the Vygotskian and IP theoretical frameworks, learning is viewed as an active, constructive process in which the learner deliberately manages available cognitive resources to create new knowledge. This is accomplished by extracting information from the environment and integrating it with existing information. In addition, the developmental level of the child must be considered in order to provide maximum instructional gain.

Limitations

A limitation to this study was the relatively small sample size (N=15) for each treatment group and the sample demographics. The results of this study can be generalized only to similar populations of second grade students.

Definition of Terms

The following definitions are given to clarify the basic words associated with this study:

Hypermedia - Hypermedia is a multimedia medium. It differs from traditional computer-assisted instructional programs in which users select from menus and are essentially directed through programs. Hypermedia is "a style of building systems for information representation and management around a network of multimedia nodes connected together by typed links" (Gay, Trumbull, & Mazur, 1991, p. 190). Learners can create their own paths through the material and construct webs of information in any way they choose. One purpose of hypermedia programs is to ensure that the user, not the designer, is at the center of the program. Thus, users are not restricted to subject matter structure or by the logic implied by the author's sequence of information.

Hypertext - Hypertext is similar to a teacher using index cards in the classroom. The teacher organizes index cards typically by key word files. The files are arranged by numerical or alphabetical sequence. Hypertext on the computer works in a similar manner. Files of electronic cards are grouped by subject. A file may contain programs which mobilize any combination of graphics, text, video or audio. The user can initiate an action by clicking the computer mouse on a screen icon called a button.

Icons - Icons are graphic representations of the action that will take place, such as an arrow that points to the right to indicate that the user will see the next screen if that icon is activated through a "button". A button is an area on the screen through which the user can initiate an action by clicking the computer mouse. Buttons are typically represented by icons.

Interactive video - Interactive video is the conditional execution of video and/or computer-based instruction based on individual learner responses.

Learner control - Learner control allows the student to determine the sequence of instructional segments.

Multimedia - Multimedia is the use of a computer to control a variety of media in a single program. Media may include text, still images, animation and simulation, motion video, and high-quality sound.

Tutorial - Tutorial instruction is presented by the computer (or other media) to the learner, generally in small segments. The user is led point by point through examples and explanations as appropriate.

Videodisc - Videodiscs are 8 or 12 inch aluminum sheets slightly thicker than standard long playing records. The data stored can be text, graphics, or sound. The information is burned by a laser into the disc surface which is then covered with a protective shell of clear plastic. The data are read by a laser inside a videodisc player either as a still frame, slow motion, or moving pictures. These images are displayed on a monitor which is connected to the videodisc. Through the computer interactions, a student can access any of 54,000 frames on the disc within one or two seconds.

CHAPTER II

REVIEW OF THE LITERATURE

Questions about the best age-appropriate uses of instructional media as supplements to classroom curriculum have been studied by human developmentalists, psychologists, educators, and instructional designers. This research began with studies that examined the developmental sequence of attention and comprehension of visual media and evolved to investigations of CBI hardware, peripherals, and their accompanying software applications. Supplementing these studies, other researchers have focused on how a child learns to think and how the teacher facilitates that learning process in settings with and without technological supports.

The Developmental Sequence of Attention and Comprehension

How young viewers process information presented through both visual and verbal symbol systems has been the focus of research efforts since the 1970's. During the formative period of early childhood, rapid change is the hallmark of one's cognitive, social, emotional and physical development. To understand the problems young children face in processing media input, attention and comprehension have received intensive study.

Research findings indicate that age differences exist in how children initially represent stimuli (Bjorklund et al., 1990; Case; 1985; Flavell, 1979; Weinert & Perlmutter, 1988). Young children encode objects primarily in terms of iconic properties, whereas older children are more likely to represent an object in terms of abstract, symbolic features. Young children also have been found to use fewer features when encoding than older children which suggests a less detailed memory representation. Speed of processing and retrieval was reported to be related to age and intelligence level. The act of processing also differs according to the degree to which experience or familiarity contributes toward absorbing the information. Processing information moves form effortful to automatic. The characteristics of effortful processes as demonstrated by older children are that they are available to consciousness, interfere with other effortful processes being executed, can be improved with practice (with the possibility of becoming more automatic over time with frequent use), and are influenced by individual differences in intelligence, motivation, and education. Characteristics of automatic processes include occurring without conscious awareness, not interfering with other processes being executed, not improving with practice, and not being affected by individual differences in intelligence. The trend is for cognitive operations to consume a lot of effort initially with less mental effort being required with practice of these operations.

The ability to visually attend to a visual medium such as television is reported to be directly related to age

(Pearl, Bouthilet, & Lazar, 1982). Before age two, a child is thought to lack cognitive development to purposively attend to television presentations (Anderson, Lorch, Field, & Sanders, 1981). Hayes and Birnbaum (1980) examined the question of whether or not children better understand television content visually than verbally. After watching a composite cartoon in which the video track from a Superfriends cartoon was mismatched with the audio portion from a Scooby Doo cartoon, preschoolers were questioned to determine recognition of information in each modality. These researchers found that children correctly recalled significantly more information from the visual track than the auditory track. The authors suggest that visual information actually interfered with verbal information processing as the preschoolers missed the major auditory manipulation in the composite cartoon.

Based on this finding, other researchers attempted to determine if visual presentation does, in fact, hinder young children's processing of verbally presented television content. Watkins, Calvert, Huston-Stein and Wright (1980) investigated the effect of presentation modes through an analysis of children's ability to recall central versus incidental program content. Sixty preschool/kindergarten and grades three/four were presented information in visual or verbal modes. The findings indicate that the mode of presentation did not affect recall of incidental content. However, especially for the preschool/kindergarten children, recall of central content was clearly aided by visually, rather than verbally, presented information.

Gibbons, Anderson, Smith, Field, and Fisher (1986) examined the effect of visual versus auditory processing on 4 and 7 year olds by measuring comprehension of information presented in either audio or audiovisual media. Information in the audiovisual format increased verbal reconstruction performance levels over the audio only stories. Four year olds recalled dialogue better in the audiovisual story than the audio story alone. In contrast to Hayes and Birnbaum, no differences were registered which indicated that visual input might hinder information processing of auditory information. Gibbons et al. argued that Hayes and Birnbaum may have confused the effect of the action in the picture with the mode of presentation.

Anderson et al. (1983) suggested that the ability to comprehend is an active process, guided by schemata. Schemata were defined as learned expectations which each viewer brings to the viewing situation which affect their understanding. These researchers contended that children's attention is guided by their expectations or what they anticipate that they will see. The majority of research studies suggest that, especially for younger children, visually presented information is more likely to supplement than to hinder verbal narration. Action, rather than visual presentation per se, improves children's comprehension of visually presented information and, thus, is probably the "superior" characteristic in this medium.

Lorch, Anderson, and Levin (1979) found that overall attention is significantly correlated with comprehension. Building on that study, Calvert, Huston, Watkins, and Wright (1982) suggested that formal features may be guiding attention. Formal features are "attributes of programs that result from visual and auditory production techniques" (p.601). Examples of these are high levels of action and sound effects. The authors examined the relationship between these features and comprehension through a comparison of kindergarten with third/fourth grade students' responses. Action and dialogue provided the modes to represent content. The authors found that these features emphasized central content and enhanced learning. Attention orienting formal features, like sound effects and vocalizations, also were reported to aid understanding by providing symbolic modes to carry out specific meanings. Few developmental differences were found between these two age groups as formal features attracted attention from both and facilitated comprehension for both.

The educational potential of visual media for enhancing visual thinking skills in 4 - 6 year olds was examined in a study by Razel & Bat-Sheva (1990). A visual skill curriculum was implemented in five nursery school classes with 5 experimental and 5 comparison classes totaling 70 and 49 children respectively. Thirty-six units were presented which trained visual skills, such as basic shapes, orientations (horizontal, vertical), colors, dimensions (length, width, height, time), and other visual elements (point, curved line). The goal was to teach the children to combine single visual elements or letters into higher-order combinations or words and then to combine several of these into even higher-order units.

The authors hypothesized that these children would be able to solve completely new problems by using the basic visual linguistic concepts and rules taught by the program. The effects of the training also were hypothesized to transfer to domains in which no direct training was given, such as normal life situations. Teaching strategies included a structured approach for teaching each new concept, beginning with passive identification of the concept. A second feature of the program was the repeated presentation of the same concept in a large number of activities. After this presentation mode was mastered, combinations of concepts were taught. The final sequence was taught using discovery learning. Test results confirmed the hypotheses. Overall, research findings illustrate that, when used in an age-appropriate manner, visual media contribute to positive learning outcomes for young children. Thus, a strong argument exists for considering visual presentations such as IVD offers as a highly facilitative instructional tool for young children.

Developmental Capabilities and Computer Based Instruction

For any technology to be appropriate for a child means that the child does not have to accommodate the technology but that the technology has to accommodate the child. Findings by Borgh and Dickerson (1983), Muller (1983), Rosen (1982), Shade, Nida, Lipinski, and Watson (1986), and Swigger and Campbell (1981) suggest that preschool and early elementary age children can easily operate within a computer workstation environment. Three-year-olds were observed to be able to manipulate a standard computer keyboard, load discs, and turn a computer on and off (Shade et al., 1986; Watson, Chadwick, & Brinkley, 1988).

Watson (1989) compared the use of computer components in early childhood education to reading a book, using crayons to color a picture, or watching "Sesame Street". He concluded that children will deal with this technology as well as they utilize reading, coloring, or watching TV, and that the technology will be utilized when the child is ready. Therefore, one could argue that managing the basic units of the computer and keyboard with age-appropriate software should not be problematic.

Research studies of CBI over the past 20 years were reviewed to be used as a baseline for attempting to gain a general understanding of both the existing and potential problems and/or solutions to multimedia/IVD research (Lepper & Gurtner, 1989). CBI treatments were found to have moderately strong effects on relevant achievement measures with an average effect size of .42 standard deviations. Thus, 66% of students receiving CBI scored at or above the median of students in a control group. However, a lack of adequate or consistent design controls in these studies greatly limits the generalizability. Seventy-two percent of the researchers failed to use random assignment of students, 51% did not control for the amount of instructional time involved, and 43% did not control for teacher effect, i.e., different teachers administering different treatments. Treatment effects were also typically confounded with possible effects of novelty, additional adult attention, differences in teaching methods and subject matter taught, and total instructional time involved in the lessons used (Clark, 1985).

Initial studies with young children registered that computers facilitate cognitive skills, language, and social development (Haugland, 1992). Kindergartners with high computer use scored significantly better on tests which emphasized symbolic uses of information. Females with higher computer use scored higher on the Peabody Picture Vocabulary Test than those without computer experience (Hoover & Austin, 1986). Kindergartners in a computer group scored higher on numeral recognition tasks than those taught by a teacher, had higher levels of language development and of cooperative play (Degelman, Free, Scarlato, Blackbun, & Golden, 1986; McCollister, Burts, Wright, & Hildreth, 1986; Muhlstein & Croft, 1986). Young children exposed to nondevelopmentally appropriate software were found to have significant losses in creativity. In contrast, young children using developmentally appropriate software had significant gains in intelligence, non-verbal skills, structural knowledge, long-term memory, and complex manual dexterity (Haugland, 1992).

The strength of all types of electronic media (film, television, video games, pinball games, computer) at home or school is thought to be in the motivational qualities that these media have for children (Gagnon, 1984). Like electronic media, print has the same component to spark the imagination and increase articulateness. Television and film add an audiovisual form of communication. These modes are thought to increase a child's skill for interpreting two-dimensional representation of movement and space. Additionally, television, computer, and video games provide the opportunity for interactive learning with a complex interaction of characters and situations.

A weakness of CBI for young children is that storylines focus primarily on male dominated adventure themes. Research studies indicate that the typical blasting noises and violent themes in children's computer programs cause females to become disinterested in computer use at an early age (Chen, 1986; Mandinach & Corno, 1985; Nelson & Watson, 1991). A gender gap also exists in experience prior to school entry, as parents typically provide computer experiences in the home for males rather than females. However, with more computers in the schools and equal computer time for both genders, females now can overcome this inequity during the first few years of school experience.

Overall, research studies indicate that CBI is developmentally appropriate to meet the physical, perceptual, and cognitive needs of young children. Consistently positive effects were illustrated in studies in which programs were designed as tutorials rather than simple drill and practice (Lepper & Gurtner, 1989). Younger students (grades K-2) showed higher posttest gains when compared to older students (grades 6-12). The key for younger students is rigorous software assessment to insure that it presents information in age-appropriate concepts and formats (Haugland & Shade, 1988).

Multimedia/IVD as an Educational Technology

In contrast to the depth of research in CBI, studies examining the effectiveness of multimedia/IVD in education over its 12 year history are limited. IVD programs used in military, private industry, and technical training provide the baseline for evaluating their effectiveness as an instructional tool. Generally positive yet small learning outcomes were reported in this literature (Bosco, 1986; Bosco & Wagner, 1988; Browning et al., 1986; Evans, 1985; Hannafin; 1985; Hannafin & Colamaio, 1987; Hannafin & Phillips, 1987; Smith, 1987). Bosco (1986) and Evans (1985) categorized these findings into four general areas: learner and/or instructor satisfaction, study time, cost effectiveness, and learning gains.

In examining learner and/or instructor satisfaction, Evans reported data from four private industry training studies. Multimedia/IVD users described a feeling of increased self-esteem. IVD was considered a less authoritarian form of teaching when compared to classroom instruction. Learners viewed the IVD trainers as managers rather than instructors. A study of governmental engineers indicated that IVD was perceived to be more stimulating and motivating than traditional instruction methods.

The motivating component originated from the "stimulating" quality of the student/IVD interaction (Leveridge, 1978: Manning, 1983: Russell et al., 1985). In research studies on instruction in both audiovisual materials and cardiopulmonary resuscitation, users registered an IVD learning benefit. Student reports indicated that the strength of the programs was the ability to concentrate on the areas in which they had deficiencies. Self-assessment and immediate correct response feedback were considered important components of the IVD program. Combined with the remediation and feedback capabilities, the richness of content presented was cited as the strongest component of IVD programs Users also indicated a strong preference for additional IVD learning opportunities.

Evans (1985) reported that significantly less study time was invested by learners using IVD programs when compared to study time associated with traditional instructional methods. Allen and Allen (1983) noted that when military technicians trained on multimedia/IVD were compared with a group trained on actual equipment, the IVD group required half the total training time. Evans suggested that this was not an unexpected finding considering the linear nature of traditional instructional techniques as contrasted to the multiple branching and unlimited remediation of multimedia/IVD.

The cost-effectiveness of multimedia/IVD programs has been calculated for the military and private sectors which have massive employee training components (Evans, 1985). Military and private industry managers report that fewer instructors with specific expertise in technological areas were needed. The educational sector also might choose this technology specifically for cost reasons (Bork, 1987; Branson & Foster, 1979; Evans, 1985). But IVD cost effectiveness for the school setting is almost impossible to calculate. Three problems are encountered in attempting to figure the cost of IVD education in public schools: (1) the difficulty of calculating the cost of initial equipment setup, (2) estimating the cost of student time and (3) the lack of planned educational outcomes.

In summary, reviews indicate that the use of multimedia/IVD programs result in increased amount of student satisfaction and reduced study time (Bosco, 1986; Evans, 1985). Students using multimedia/IVD programs also reported higher levels of motivation and alertness. Statistically significant increases in pre-to-posttest learning also have been reported (Bosco & Wagner, 1988; Browning et al., 1986; Glenn et al., 1984; Hannafin, 1985; Hannafin & Colamaio, 1987; Hannafin & Phillips, 1987; Hasselbring et al., 1987; Russell et al., 1985). Hannafin (1985) concluded that these gains result primarily from immediate feedback in self-testing and the capability to branch for review which improved recall of study content. As an educational technology, instructional imagery systems are highly regarded since they are thought to activate the highest number of senses, make the highest number of connections within the child's existing framework, and provide the most motivating stimuli as any other instructional delivery system.

Developmental Appropriateness of Multimedia/IVD for K-2 Children

Multimedia/IVD technology provides an abundant diversity of instructional formats, i.e., text, graphics, film, etc.). The need for diversity is well documented by cognitive psychologists. Research findings indicate that there is no one universal way of learning. Over 30 different learning styles have been identified (Ellis & Hunt, 1989). Within styles, different learners use varying strategies on the same task. The same learner also may have sufficiently divergent cognitive skills to select different strategies for different tasks. Research findings indicate that students are more likely to initiate, sustain, direct, and actively involve themselves in a learning setting when they believe success or failure is due to factors within their control. Positive reactions to IVD instructional programs and enjoyment of the IVD self-pacing capability were reported results (Evans, 1985; Hasselbring et al., 1987; Russell et al., 1985). The inputs of text, graphics, animation, sound, and video, combined with the flexibility of moving through a program according to the learner's choices and speed, should make multimedia/IVD an ideal instructional delivery system for young children (Nelson, Watson, & Busch, 1989).

Research is lacking for the population of early elementary age population (K-2) (Char, Newman & Tally, 1987). One research study has been conducted on multimedia/IVD with first grade students (Nelson, Watson, & Busch, 1989). In this study, a multimedia/IVD lesson on whales and seals was compared to a classroom lecture. Sixty first grade students were administered one of 3 levels of treatment: the IVD lesson, the IVD lesson with teacher mediation, or a classroom lecture. A control group received no treatment. Teacher mediation was in the form of scripted verbal reinforcers. Students in the "traditional" classroom lecture group were read text identical to the IVD lesson text. The same graphics and still frames used in the IVD lesson supplemented the text.

The adjusted posttest gain scores revealed a significant difference between the groups who received the IVD lesson treatments and the classroom lecture and control groups. The groups who received the treatment of IVD, with and without verbal reinforcers, scored significantly higher gains than the lecture and control groups.

The success of the IVD lesson was thought to be partly explained by student's ability to reorder learning from a conventional linear approach to a self-paced form which more closely approximates the student's real world experiences. Through the IVD presentation system, the student is also exposed to a richness of imagery inputs. The results of this study led to the conclusion that IVD lessons could be a very powerful and appropriate instructional device for early elementary students.

Teacher scaffolding

With developmentally appropriate software, multimedia/IVD workstations function like any other learning center in a school setting. Teachers move among the children, responding to questions or proposing hypothetical situations. This allows students the opportunity for teacher "scaffolding". Scaffolding is defined as a "process that enables a child or novice to solve a problem, carry out a task or achieve a goal which would be beyond his unassisted efforts" (Wood, et al., 1976, p. 90). Teacher scaffolding enables students to explore situations and objects for which they lack the prerequisite skills or knowledge.

In interaction with younger children, a teacher may rearrange the pieces of a puzzle so that they are right side up or steady the bottom blocks in a tower. The goal is to enable a child to continue the task at hand. Verbal interaction could be in the form of reminding the child of what they are doing, rejecting false starts, and/or guiding an information search. The same types of scaffolding interactions should be appropriate and effective for a child using multimedia/IVD lessons (Emihovich & Miller, 1986; Markham, 1985).

The concept of scaffolding was refined to specifically refer to the steps taken to reduce the "degrees of freedom" in carrying out some task, so that the child can concentrate on the difficult processing skills (Bruner, 1978). Teacher scaffolding generally is viewed as a joint interaction in which students and teacher share the responsibility for learning. This exchange enables both the student and teacher to further refine their own give and take about the subject or processes under consideration. In this context, the question facing an educator is how to best assist the student in guiding them from one level of competence to the next (Beed, Hawkins & Roller, 1990; Emihovich & Miller, 1986; Wood et al., 1976).

The steps for designing a scaffolded lesson with multimedia/IVD follow the traditional approaches with non-technology lesson plans with one notable exception (Applebee & Langer, 1983). The traditional process includes evaluating the selection of the subject domain and processes that are to be taught within that topic. The teacher must determine the specific areas of difficulty that the learner will most likely encounter (Hess & Holloway, 1983; Wood et al., 1976).

This assessment includes selecting the key points or processes in a specific lesson and the way these sections might be best organized for presentation. The remainder of the planning stage for scaffolding of traditional planning includes modeling, questioning, and explanation of the subject or process being taught (Applebee & Langer, 1983; Beed, et al., 1990; Wood, Wood, & Middleton, 1978).

The difference in a multimedia/IVD program is created by the menu format (Gay, 1986; Gay, et al., 1991). Menus permit students to randomly choose how to travel through the available information. The key points in a linear lesson are reasonably easy for an instructor to select. However, this step becomes particularly problematic in a scaffolded sequence. With menu selection, the teacher has no control over the organization of the material, other than in the broad categories offered. The problem rests in finding creative ways to focus attention on the salient content whenever a key point or process appears in the program regardless of the amount or nature of prior information. Extra planning and flexibility in lesson planning are necessary to overcome the difficulty presented in the open-ended multimedia/IVD program structure.

Incorporating teacher scaffolding into interactive CBI has been successfully managed and cited as an effective supplement to CBI in research literature (Brinkley & Watson, 1989/90; Clements & Gulla, 1984; Easton & Watson, 1990; Emihovich & Miller, 1986; Fay & Mayer, 1987; Fay & Mayer, 1988). The most dramatic demonstration of its success is in the findings on a computer program for young children called LOGO. LOGO, invented by Seymour Papert, is an application which teaches young children a computer programming language (Papert, 1980). Papert initially proposed that a young child could use LOGO without any type of teacher mediation. He argued that using LOGO would lead to the development of cognitive skills, particularly in the area of problem-solving. In addition, Papert hypothesized that these skills could be generalized and transferred to other content or skill areas.

Investigations of Papert's claims are divided into two chronological periods, defined by the research questions examined in each phase. During the first period from the early to mid-1980's, researchers focused on Papert's hypothesis that positive learning outcomes would generalize to other similar skill areas. Numerous early studies indicated that no significant differences were registered on tests of planning skills in score comparisons with non-treatment groups (Kurkland & Pea, 1985; Linn, 1985; Nickerson, Perkins, & Smith, 1985; Pea & Kurkland, 1984, Perkins, 1985; Webb, 1984). Similarly, Dalbey and Linn's (1985) review of research in this period found that students who learn LOGO fail to generalize this learning to other tasks.

Cognitive psychologists' research findings on thinking skills during this same time period illustrated the importance of the mode of content presented to students. A recurring theme in this literature was that no content, standing alone, could spontaneously produce generalizable learning (Bransford, Sherwood, Vye, & Reisser, 1986). This outcome was replicated in the LOGO research. Positive transfer was registered when a teacher guided method of instruction was added to the program curriculum (Clements & Gullo, 1984).

In the late 1980's, LOGO research examined the effectiveness of different types of teacher mediation used with LOGO curriculum. A number of studies were conducted by J. Allen Watson with the Children and Technology Project at the University of North Carolina at Greensboro. This preschool LOGO curriculum included teacher scaffolding specifically designed to build on a careful pattern of learned strategies. Subjects with teacher scaffolding registered significant learning gains in programming skills as well as gains in transferring these skills to other tasks or areas (Brinkley & Watson, 1989/90; Clements & Gulla, 1984; Easton & Watson, 1990). The general conclusion, supported in similar studies, was that teacher scaffolding was an effective instructional supplement to be added to CBI and that both significantly contributed to learning gains (Fay & Mayer, 1987; Fay & Mayer, 1988).

Comprehension Monitoring

Teacher scaffolding and comprehension monitoring core techniques seem to address its interactive nature. Teacher scaffolding consists of a dialogue between the teacher and learner. Comprehension monitoring also consists of an active dialogue; an internal one within the learner (Miller, 1984; Miller, 1990). As children problem solve, they are continually questioning themselves and seeking answers (Wertsch, 1979).

Prediction, question generation, summarization, and clarification often were processes targeted for instruction because they were thought to be the techniques that could improve understanding of text (Baker & Brown, 1984; Levin & Pressley, 1981). For example, in order to pose a question, a student first must identify key information in the text, put that information in the form of a question, and self-test for understanding and recall. This type of singular self-debate is noted to enable children to construct novel strategies and methods of putting together new cognitive procedures (Bjorklund et al., 1990).

The study of comprehension monitoring initially focused on error detection tasks in children's ability to listen to or read text and stories (Baker & Anderson, 1982; Dewitz, Carr, & Patberg, 1987; Flavell et al., 1981; Harris, Kruithof, Terwogt, & Visser, 1981; Patterson, Cosgrove, & O'Brien, 1980). In these studies, the information presented contained errors or anomalies. Story or text content ranged from familiar, general subjects, such as plants, to unfamiliar, specific knowledge, such as magnetism. Overall, children with high comprehension ability were found to be better at monitoring, controlling, and adapting their processing strategies than those with lower ability (Brown, Palincsar, & Armbruster, 1984). When the topic was familiar, even first grade children could identify inconsistencies in a listening mode. However, unfamiliar information failed to produce recognition at this grade level. The strongest mechanism that bolstered test outcomes were lessons which included specific comprehension monitoring techniques.

Researchers have suggested that changes in memory span which contribute to effective comprehension monitoring are due to developmental differences in the use of strategies, such as rehearsal or chunking (Bjorklund, 1989; Bjorklund et al., 1990; Flavell, 1979). The speed of processing is found to increase as children mature. Student performance is defined by the stage of task solution attained. The stages include encoding of stimulus, comparison between stimuli, and response components which reflect the retrieval of pertinent task information (Harnishfeger & Bjorklund, 1990). Progression through these stages is hypothesized to produce maturational differences. When the level of memory span increases, less mental effort is required for execution.

Case (1985) proposed that memory capacity remains relatively constant across development, but that age differences occur in the efficiency of information processing. His findings suggest that development occurs as older children require less operating space for the execution of cognitive processes than younger children need. The additional processing space is thought to leave more store in which to process other operations.

Lack of metamemorial knowledge is thought to account for the production deficiency of younger children (Andre, 1979; Anderson & Reder, 1979; Bjorklund et al., 1990; Brown & Palincsar, 1982). Developmental differences have been found by age differences in children's metacognitive knowledge which included memory, reading comprehension, attention, communication, imitation and self-monitoring (Baker & Anderson, 1982; Brown et al., 1984; Dewitz et al., 1987; Flavell et al., 1981; Harnishfeger & Bjorklund, 1990; Harris et al., 1981; Miller, 1990). Typically, young children do not use memory strategies which are available and known to them. Educators who have used curriculum based on bolstering monitoring strategies found improvements in reading, learning, and memory achievements for both average and below average subjects.

On task selection, young children are found to give a disproportionate amount of attention to irrelevant information, ignoring critical features of the task (Bjorklund, 1989; Bjorklund et al., 1990). When selectively comparing information, young children are less likely to relate the new information to what they already know. Older children use more efficient attention allocation and more efficient storage processing strategies. In general, as children gain more knowledge, they also gain a broader base for making selective comparisons which produces more efficient memory processing. This, in turn, produces a continuous feedback loop between knowledge acquisition and performance processes as children move from relatively simple to more complex levels of thinking (Howe & O'Sullivan, 1990).

Researchers have reported that increased involvement in an activity through comprehension monitoring techniques created both faster and more thorough CBI recall and synthesis (Easton & Watson; Howe & O'Sullivan, 1990; Miller, 1984; Miller, 1990; Miller & Emihovich, 1986). However, little is known about the instructional variables that can affect young children's comprehension monitoring or metacognitive abilities that would be necessary for a child to do this. Young children can monitor comprehension when task demands are reduced (Miller, 1990). Children who are taught self-monitoring strategies during instruction were found to have (1) more active involvement, (2) a routine to aid in organizing new content with current knowledge or framework, and (3) a means to maintain and generalize through a trained (learned) strategy.

In summary, research evidence indicates that the age-appropriate multimedia/IVD software increases student learning when compared to traditional lecture forms of presentation (Nelson, Watson, & Busch, 1989). Findings from research studies on attention, comprehension, and cognition reveal that K-2 students may not be able to monitor their own comprehension with the same competency as middle grade students (Miller, 1990). Educational research studies on teacher-student interactions and student reading and memory reveal the significant contribution of teacher scaffolding techniques and student self instruction. The consensus from current empirical studies suggests that the key to a sound developmental approach to learning any subject is, first, to determine a child's physical, cognitive, and perceptual skills and match these to the task demanded in the software program (Haugland & Shade, 1988).

Since children interact with the world differently, this technology provides a good fit since it offers different ways for young children to learn. The multiple modes of input are part of this. Children can read text while the listening to digitized sound which also "reads" the text to them. Graphics and animation provide a second way to illustrate concepts and processes. Finally, the video sequences let students see and hear the subject content as it naturally exists.

Hypotheses

We believe that multimedia/IVD software programs are appropriate for young children both as a stand alone technology and when supplemented with age-tested teaching and learning strategies. The study had four specific research hypotheses:

H_1: The IVD lesson only group will have significantly higher adjusted knowledge test scores after controlling for preexisting differences.

H_2: The comprehension monitoring treatment group will have significantly higher adjusted knowledge test scores than will the IVD lesson only group.

H_3: The teacher scaffolding only treatment group will have significantly higher adjusted knowledge test scores than will the comprehension monitoring only or IVD only groups.

H_4: The teacher scaffolding with comprehension monitoring treatment group will have significantly higher adjusted knowledge test scores than will the teacher scaffolding only, the comprehension monitoring only, and the IVD only groups.

CHAPTER III

METHODS AND PROCEDURES

Subjects

Subjects were recruited from the second grades in two Guilford County Public Schools, Millis Road and Southwest Elementary, in Guilford County, N. C. The students' ages ranged from 6 to 8 years in both schools. Millis Road Elementary School provided 38 subjects for the instrument validation process. A 79 item multiple choice test was constructed to measure students' content knowledge of "Wise Lifty's Primates". Treatment and control groups were formed with 19 students each. The treatment was the multimedia/IVD lesson, "Wise Lifty's Primates", followed by the test questions. The control group received the test questions only.

Four classrooms from Southwest Elementary School formed the pool of subjects for the study. Sixty students were administered one of 4 levels of treatment: the IVD lesson only, comprehension monitoring only, teacher scaffolding only, and teacher scaffolding with comprehension monitoring. The subjects in the treatment groups were randomly assigned. To control for gender effect, the sample was analyzed to determine the proportion of males and females prior to group assignment. Of the 63 students with parental approval, 58%

were males and 41% females. In the final sample of 60, 34 were male (57%) and 26 were female (43%). The IVD lesson only and teacher scaffolding only groups had 8 males (53%) and 7 females (47%). The comprehension monitoring only and teacher scaffolding with comprehension monitoring groups had 9 males (60%) and 6 females (40%).

Design

A two factor pretest-posttest control group true experimental design was used (Campbell & Stanley, 1963). The factors were teacher scaffolding (TS) and comprehension monitoring (CM). Each factor had two levels represented by the presence or absence of the instruction or strategy technique (TS and No TS, CM and No CM).

Several design controls were developed to increase the generalizability of the results. To control for teacher effect, teachers were randomly assigned to subjects. To control for prior computer experience, each student had a multimedia/IVD practice lesson the day before the treatment lesson. To control for differences in teaching methods, detailed protocols were developed for each treatment. To control for the inappropriate use of a treatment, the groups were ordered from the one requiring the least teacher/student interaction to the one requiring the most.

Multimedia/IVD Treatment Lesson

"Wise Lifty's Primates" is a repurposed multimedia/IVD program for second grade students. After examining a variety of K-2 curriculum guidelines and subjects, this instructional lesson was designed around an age-appropriate developmental approach to teaching and learning. The learning objectives were designed to teach the scientific processes of classification and problem-solving through observing, comparing, and contrasting two species of primates, apes and monkeys. These animals were judged as appealing to second graders as they are so human-like yet exotic. They also provided a good way to explore the area of biological classification through physical characteristics, diet, and locomotion. This information was placed in the child's own framework through concepts with which he/she is already familiar, such as hands and arms, food, and movement.

"Wise Lifty's Primates" is an interactive learner controlled tutorial. A variety of media provide multiple perceptual inputs, including moving videodisc images and sound, and computer generated graphics and animation. Digitally recorded voice accompanied the text on each screen. A special button, identified by a pair of lips, let the child listen to the same screen of text as many times as she/he wished. The IVD segments were repurposed from the videodisc, Encyclopedia of Animals: Mammals, Vol. 3 by Pioneer LaserDisc Corporation. This lesson was developed with a multimedia authoring package, MacroMind Director.

The design team for this project was headed by J. Allen Watson, Director of the Children and Technology Project at the University of North Carolina at Greensboro. Project members consisted of six graduate students in the Department of Human Development and Family Studies with differing backgrounds in preschool and elementary education, a public school administrator for multimedia technology, a K-2 teacher with a background in CBI design and evaluation, and a test expert who specialized in preschool and elementary age children. The lesson was assessed as age-appropriate in both content and process presentation through the CBI technology review processes in the Guilford County School System.

To give the student the mental framework and motivational appeal for this exploration, "Wise Lifty's Primates" begins by setting a theme for the student. "Wise Lifty", a fictional animated monkey, acts as the students' narrator and guide throughout the jungle scenario. Lifty begins by enticing the child's assistance to help identify some newly arrived animals so they could locate their friends.

The processes of classification and problem-solving are presented in three lesson components. First, definitions of key terms are explained in age appropriate phasing. Then they are illustrated with voice-accompanied text, graphics, and animation by comparing and contrasting two candies: M&M's and Skittles. With a cluster of candies illustrated on the screen, Lifty first points out that M&M's and Skittles are alike in that they are both small, round shaped candies. Next, an animated sequence shows these two candies collide, splitting in half. With the center portion of the candies displayed, the narration and text note that the candies also are different as M&M's are chocolate but Skittles are not (see Appendix B).

The second section of the lesson presents content knowledge through comparing and contrasting apes' and monkeys' physical attributes, diet, and locomotion. General classification is made through features unique to apes and monkeys, such as what they eat and how their hands and arms function (see Appendix C). For example, if a student selects the "What they eat" topic, the narration and text explain:

> Both apes and monkeys eat many parts of plants such as leaves, stems, shoots, berries, and fruits. They also eat small insects such as grasshoppers, ants and termites.

Included on the screen are buttons with graphics of leaves, termites, and grasshoppers. On selecting one of these, the student sees a video segment of an ape or monkey eating the food depicted. Verbal reinforcers focus the child's attention to the salient information in the footage.

The variations among their features are also discussed. In a section titled "Differences between apes and monkeys" the topics of noses, rears, and locomotion are presented. If the student chooses the topic "Locomotion", a definition screen indicates "Locomotion means moving from one place to another". An animated train engine with a monkey passenger travels from one side of the screen to the other. Next, a submenu with graphic buttons of an ape and monkey appears. If the ape is selected, several scanned pictures of long armed orangutans are displayed. The voice-accompanied text reads: "Apes move through the trees by swinging their arms. This is called brachiation. (BRAY-kee-A-sun)". A button with a video monitor appears at the bottom of the screen. Activating this button produces a video segment bringing this concept to life as an orangutan gracefully traverses the upper branches of the trees. The next screen has a graphic of a gorilla. The text indicates that "Apes can also walk on the ground. They use their feet and the knuckles on their hands to walk. This is called 'knuckle walking'". When the monkey graphic was chosen from the submenu, the text and narration explain "Monkeys run along on branches or on the ground". The accompanying video shows a group of monkeys' scampering on all fours through some jungle undergrowth. The shot changes to the same species of monkey propelling itself from tree to tree using both its hands and feet.

In the final section, the student applies the process of classification in a problem-solving format. In each of four problems, the student is asked to recall specific content knowledge. Next, a question is posed (see Appendix D). For example, another contrast the students learned is that an ape's nose is wide and flat while a monkey's is longer and narrower. The corresponding problem-solving sequence begins with a screen showing a large mound of leaves. Lifty's voice says: "Shhhh! There's a primate behind the leaves." An animated proboscis monkey slowly protrudes his head. "What a sight! It has a funny nose that wobbles." The screen changes to read "Look at these primates' noses. Which primate has a long nose?" Three button choices are offered: a chimpanzee, a gorilla (both apes), and proboscis monkey. Selecting a button produces video footage of that animal with an audio reinforcer directing the students' attention to the shape of the nose.

After these choices are viewed, the answer segment appears. This unit requires recall and synthesis in order to respond to the question (see Appendix D). The three choices are scrambled in a different order and the question is asked again. The student receives feedback in the form of text, audio, and video reinforcers at the point at which an error is made. Summary screens reviewing the salient points in the lesson and a final farewell from Lifty conclude the lesson.

Test Construction and Instrument

A multiple choice test was constructed to measure student's content knowledge of "Wise Lifty's Primates". To construct this test, the project team's test expert and two graduate students drafted 79 questions (see Appendix E). Millis Road Elementary School second grade students from two intact classrooms provided the subjects. Letters explaining the study were distributed to the students' parents by the classroom teachers (see Appendix F). Treatment and control groups were formed with 19 students each. The treatment consisting of the multimedia/IVD lesson, "Wise Lifty's Primates". This program was administered to each child individually. Next, the test questions were administered to these students as a group. Each student was provided with a scoresheet. Each question was presented on a transparency via an overhead projector as it was read to the students. The control group received the same format for the test questions.

The students' responses to the questions were coded on Scantron sheets. An item analysis was conducted on each group to determine the proportion of students who correctly responded to each question. Questions which both groups answered correctly were discarded. Questions which neither group could answer were rewritten or discarded.

The test instrument contained 25 multiple choice items. The test was written into a computer format using Apple's HyperCard authoring program (see Appendix G). Each question and answer was recorded through an audio digitizer application called MacRecorder. The audio allowed the students to hear the questions or answers separately as many times as they wished by "clicking" on the text.

A pilot test on "Wise Lifty's Primates" also was conducted. Two goals were accomplished. First, the clarity of the instructions which guided the students through the program were refined. Second, the clarity of presentation of the software navigational methods and content was evaluated. An unexpected finding was that the students would listen to and each others answers during "Wise Lifty's" problem-solving component. To prevent this from invalidating the pre- and posttest results, the students used headphones which restricted the sound to the user only.

Multimedia/IVD Practice Lesson

On the day prior to the treatment, each student had a practice session. Three objectives were accomplished. First, the children became familiar with the hardware components of the computer mouse, hard disk and monitor, and the IVD monitor. Second, the software requirements and navigation methods were explained and practiced. Third, the two groups which had comprehension monitoring as a treatment were trained to use this strategy.

The practice lesson was a repurposed, multimedia/IVD program titled "Sea Mammals". A prior research study validated this program as age-appropriate (Nelson, Watson, & Busch, 1989). Media inputs included videodisc still and moving images, graphics, animation, digital sound, and text. The teacher read the text to the student throughout the program. A videodisc entitled "Encyclopedia of Animals": Mammals, Volume 1" was accessed through the computer program for the visual and sound databases which supplemented the text.

The lesson has two separate sections, one on whales and another on seals. Four introductory screens defined and illustrated the general category of sea mammals through text and videodisc segments. Next, the primary menu appeared with graphic buttons of both a whale and a seal. The child was asked "Now, you can learn more information on either whales or seals. Which would you like to learn more about?" The child's selection of one of these graphics led the user to the submenu. Each section covered the same six topics: their habitat, the largest family member, the smallest family member, how they breath, move and care for their young.

Each of the constructs was described with text and reinforced with videodisc. For example, in the whale's habitat section, the text reads "There are two members of the whale family. They are called dolphins and whales. All members of the whale family live in the water." An icon of a monitor is next to the text. The child was instructed to click the computer mouse on the icon. A moving picture, about 45 seconds in length, showing dolphins and whales swimming in the ocean followed. The same general format was provided for each construct (see Appendix H).

Equipment

Research equipment was supplied by the primary researcher, UNCG, and the Guilford County School System. The components in one workstation included a Macintosh Centris 610 with color monitor, a Pioneer LD-4200 laserdisc player and color monitor. The second workstation consisted of a Macintosh LC III microcomputer with color monitor for the "Wise Lifty's Primates" program, a Macintosh SE/30 for "Sea Mammals", and a Pioneer LD-4200 laserdisc player and color monitor. The testing room was the school studio. This room, off the media center, provided a maximum amount of privacy and included age-appropriate sized tables and chairs.

Variables

Comprehension Monitoring. Increasing the learner effort and involvement in a lesson has been found to improve learner performance (Anderson & Reder, 1979; Bjorklund et al., 1990; Salomon, 1983). With multimedia/IVD, types of interaction range from simple start-stop decisions through elaborate feedback, practice, and remedial exercises (Hamaker, 1986; Rickards, 1979; Wager & Wager, 1985). Such forms of feedback are thought to improve a child's ability to learn factual information, but limit learning high-level information (Andre, 1979). Higher-order learning is critical for the student to integrate new information with material previously encoded for producing process and procedural knowledge. Comprehension monitoring techniques are designed to create an active dialogue within the child. This type of self-debate is thought to give learners ways to construct new cognitive procedures. The goal of comprehension monitoring during instruction is to provide students with a more active involvement, a routine to aid in organizing new content with current knowledge or framework, and a means to maintain and generalize through a trained strategy (Miller, 1990).

For this study, the children in the CM and TS/CM groups were taught to review four questions while navigating the practice lesson, "Sea Mammals". The questions were: What's the subject? What's the question I'm trying to answer? What are the choices? What's important to remember? and What is the answer? The teachers used a four phase training procedure adapted from LOGO research studies (Miller, 1985; Easton & Watson, 1989).

Teacher scaffolding. Teacher scaffolding also requires interaction techniques predicated on an active dialogue. The interaction, however, is initiated by the teacher to create dialogue with a student. The primary task is to focus attention on salient points by eliciting reactions or responses from the student whenever a critical point or process occurs. As noted in Chapter 2, scaffolded lessons for multimedia/IVD software are designed the same way as non-technology lessons are with one notable exception (Applebee & Langer, 1983). Multimedia/IVD menus allow the learner to randomly select the order in which lesson content is presented. Random construct selection denies the teacher control over when material is presented, making the student's prior knowledge to that point unpredictable.

To solve the problem of random topic choice, a "metascript" was designed for this study. The term "metascript" refers to verbal instruction that has a general format and guidelines within which scaffolded instruction can be framed (Palincsar, 1986). This model also contains the use of strategies called "reciprocal teaching" which eliminates the restrictiveness of a bound script. The term reciprocal describes the give and take through exchange between one person and another by way of response or reaction. The open-ended questions used in this model are based on forming a metascript within the five levels of responses developed by Wood et al. (1976) and adapted for educational application by Beed et al. (1991).

The instructional program was evaluated to determine the specific areas of difficulty that the learner would encounter. This evaluation enabled the teacher to determine how to make the task easier to absorb and connect to existing knowledge (Hess & Holloway, 1983; Wood et al., 1976). In "Wise Lifty's Primates", eleven specific segments were identified as the critical points for teacher initiated dialogue. The teacher also responded to any student generated dialogue during the program using a standard format for scaffolding which includes modeling, questioning, and explaining the subject or process being taught (Applebee & Langer, 1983; Wood et al., 1976).

Dependent Variable. The dependent variable was the adjusted posttest score on the 25 item knowledge test.

Procedure

Data Collection. Parental consent letters were distributed to each member of the 4 second grade classrooms at Southwest Elementary School (see Appendix I). The letters explained the nature of the study and the types of instruction being offered. If permission was granted, the responsible adult was required to sign and return the consent form.

The second grade teachers introduced the project to the students by reading the following script: "We have a wonderful treat to offer those of you who think that this would be fun. Some friends from the University of North Carolina at Greensboro have two very special computer and video programs for you. One gives information about whales and seals while apes and monkeys are on the other. They're special programs because they have something you've never done before. They use all the things you've seen before on a computer like text, graphics, animation, and sound. But these have an extra bonus. They use video pictures played from a disc that looks like a big CD disc. This bigger disc is called a laserdisc. If you think you'd like to use these programs, please take this letter home with you tonight for your parent/guardian to sign and bring it back tomorrow. You don't have to do this if you don't want to. But if you really want to do this, we need your parent's OK as with all other special events. Any questions?"

Experimenters. Two female data collectors administered the pretests and posttests as well as the treatments. Both had experience instructing young children. The first was a master's level, certified teacher in early elementary education. The second was a doctoral student in Human Development and Family Studies who had prior experience with young children and with scaffolding strategies.

Protocols. Sixty students were administered one of 4 levels of treatment: the IVD lesson only, comprehension monitoring (CM) only, teacher scaffolding (TS) only, and teacher scaffolding with comprehension monitoring (TS/CM). To control for differences in teaching methods, detailed protocols were developed for each treatment. An equipment and pretest protocol allowed the teacher to (1) determine the child's prior computing experience, (2) introduce the equipment to the child, (3) introduce the pretest (see Appendix J). The teacher first identified each hardware component, i.e., the computer on/off button, screen, and mouse. Then the functions of the computer mouse and mouse button were explained. Next, the researcher demonstrated how the mouse and mouse button were manipulated. The child was offered the opportunity to manipulate the mouse and practiced moving it. Finally, the instructions for the pretest were given.

Two protocols introduced the student to the practice and treatment lessons for the IVD lesson only group. The primary responsibility of the teacher was to define the content of each lesson and identify the purpose of the programs' buttons (see Appendix K). The teacher read the "Sea Mammals" text to the students. As "Wise Lifty" had voice-accompanied text, the teacher only prompted if the student seemed confused about the button functions (see Appendix L).

The children in the CM and TS/CM groups were taught to review four questions while navigating the practice lesson, "Sea Mammals" (see Appendix M). The questions were: What's the subject? What's the question I'm trying to answer? What are the choices? What's important to remember? and What is the answer? The student held a card with these questions listed as a reference. The teachers used a four phase training procedure. The phases were designed to allow the child to gradually develop a level of comfort in the use of this process. The teacher first modeled the steps for the student on two lesson constructs. She then asked the student to join her in going over the steps. Finally, she asked the student to use the steps independently. An unlimited time was available for review. For "Wise Lifty's Primates", the teacher's role was limited to modeling the comprehension monitoring steps for the introductory section and then prompting at designated points for the remainder of the program.

The teacher scaffolding protocol provided general information about the purpose and objectives (see Appendix N). Cueing levels described the progression from modeling, to guided practice and, finally, to independent practice. The same scaffolding process was used for both "Sea Mammals" and "Wise Lifty".

While the students in the CM group worked independently during the treatment program, the monitoring steps were incorporated into the scaffolded dialogue for the TS/CM group (see Appendix O). If an incorrect answer was given, the teacher followed the monitoring steps with the child in an open-ended dialogue. The T/S level progression format was maintained as a guide for the types of scaffolded responses used. Detailed scripts were used to introduce this process to the child.

Data Analysis

A one-way analysis of variance (ANOVA) was conducted on pretest knowledge scores to determine if the subjects in the four treatment groups were equivalent at pretest. An analysis of covariance (ANCOVA) was used to used to test each of the four hypotheses (Elashoff 1969; Glass & Hopkins, 1984). The covariate was the pretest knowledge score.

CHAPTER IV

RESULTS

This research project was designed to investigate the effectiveness of a multimedia/IVD instructional program for second graders in two areas. The first focused on the appropriateness of multimedia/IVD technology as an instructional tool. The second examined the strategies of comprehension monitoring and teacher scaffolding alone and in combination as a supplement to multimedia/IVD. The study had four specific research questions, listed below with their respective hypotheses:

1. Is a multimedia/IVD lesson an effective instructional tool for second grade children?

   H_1: The IVD lesson only group will have significantly higher adjusted knowledge test scores after controlling for preexisting differences.

2. Is comprehension monitoring an effective supplemental strategy when combined with multimedia/IVD programs for second grade children?

   H_2: The comprehension monitoring treatment group will have significantly higher adjusted knowledge test scores than will the IVD lesson only group.

3. Is teacher scaffolding an effective supplemental strategy when combined with a multimedia/IVD program for second grade children?

   H_3: The teacher scaffolding only treatment group will have significantly higher adjusted knowledge test scores than will the comprehension monitoring only or IVD only groups.

4. Is the combination of teacher scaffolding with comprehension monitoring an effective supplemental strategy when combined with a multimedia/IVD program for second grade children?

   H_4: The teacher scaffolding with comprehension monitoring treatment group will have significantly higher adjusted knowledge test scores than will the teacher scaffolding only, the comprehension monitoring only, and the IVD only groups.

To address these questions, 60 second grade students were administered one of 4 levels of treatment: the IVD lesson only, comprehension monitoring only, teacher scaffolding only, and teacher scaffolding with comprehension monitoring. The results are presented in three sections. First, the descriptive statistics and the statistical analysis on the group pretest scores are reported. Second, descriptive statistics and statistical analysis on the group posttest scores are detailed. Finally, each hypothesis and respective statistical analysis is presented.

<u>Pretest Scores</u>

The average number of test items correctly answered across all groups at pretest was 12.3 (49%). The students in both the comprehension monitoring and the teacher scaffolding groups registered the highest (and identical) pretest score means of 12.9 items correctly answered (52%) (see Table 1). The control group registered a mean of 12.7 (51%). The students in the teacher scaffolding with comprehension monitoring registered the lowest pretest score with a mean of 10.7 correct responses (43%).

A one-way analysis of variance (ANOVA) on pretest knowledge scores was used to examine whether subjects in the four treatment groups were equivalent at pretest. There was not a statistically significant difference in the pretest scores ($p = .0784$) at the .05 level (see Table 2). The group who received teacher scaffolding with comprehension monitoring had lower scores than did the other groups. The R^2 for this model was 11%. It was concluded that the groups were statistically equivalent in knowledge about apes and monkeys prior to the treatments.

<u>Posttest Scores</u>

An analysis of covariance (ANCOVA) was used to test each of the 4 hypotheses. The independent variable was the

Table 1

Means and Standard Deviations

on Pretest Content Scores For Each Group

(n = 15 per group)

Group	Mean	SD
IVD Lesson Only	12.7	2.5
Comprehension Monitoring	12.9	3.3
Teacher Scaffolding	12.9	2.2
Teacher Scaffolding/ Comprehension Monitoring	10.7	2.6

Table 2

One-Way Analysis of Variance Summary

on Pretest Knowledge Scores by Group

Source	df	SS	MS	F	p
Treatment Group	3	52.45	17.48	2.39	.0784
Error	56	409.73	7.32		
Total	59	462.18			

treatment with 4 levels: the IVD lesson only, comprehension monitoring only, teacher scaffolding only, and teacher scaffolding with comprehension monitoring. The covariate was the pretest knowledge score. The dependent variable was the adjusted posttest score on the test. The adjusted average score of correctly answered test items after the treatments was 18.07 (72%). The teacher scaffolding with comprehension monitoring group registered the highest posttest scores with an average of 20.5 items (82%) correctly answered for a gain of 9.8 items (39%) (see Table 3). Teacher scaffolding only produced the second highest mean of 18.9 (76%) with an average gain of 6.0 (24%). The comprehension monitoring only group was third with an average of 17.6 (70%) correct items and a gain of 4.7 (19%). IVD lesson only registered the lowest increase with an average of 15.3 items (61%) and a gain of 2.6 (10%). There was a significant group effect ($p = .0001$). The results of that analysis are summarized in Table 4. The null hypothesis of equal adjusted posttest means was rejected.

T-tests were used to compare each group's adjusted posttest score to zero (i.e., t-tests for significant change). Each of the 4 groups demonstrated significant change from pretest to posttest ($p = .0001$). A series of t-tests were used to compare particular group means to other groups based on each hypothesis. The results of these t-tests will be discussed separately for each hypothesis.

Table 3

Means and Standard Deviations

on Lesson Content Knowledge Scores For Each Group

(n = 15 per group)

	Pretest Score		Posttest Score		Adjusted Posttest Score	
Group	M	SD	M	SD	M	SD
IVD Lesson	12.7	2.5	15.3	2.4	15.21	.05
Comprehension Monitoring	12.9	3.3	17.6	2.3	17.44	.05
Teacher Scaffolding	12.9	2.2	18.9	2.4	18.71	.05
Teacher Scaffolding/ Comprehension Monitoring	10.7	2.6	20.5	2.9	20.90	.05

Table 4

Analysis of Covariance for Knowledge Test

on Adjusted Dependent Measure

Source	df	SS	MS	F	p
Pretest	1	29.85	29.85	5.06	.0285
Group	3	238.25	79.42	13.46	.0001
Error	55	324.55	5.90		
Total	59	565.73			

Hypotheses

H_1: The IVD lesson only group will have significantly higher adjusted knowledge test scores after controlling for preexisting differences. To test this hypothesis, a pre-planned comparison (t-test) was used to compare the group adjusted posttest score to zero. A significant change from pretest to posttest was registered ($p = .0001$) (see Table 5). This hypothesis was accepted.

H_2: The comprehension monitoring treatment group will have significantly higher adjusted posttest scores on the knowledge test than the IVD lesson only group. To test this hypothesis, a pre-planned comparison (t-test) was made between comprehension monitoring and the IVD lesson only groups. A significant difference was registered between these two groups after the effects of the pretest scores were controlled. The students who received the treatment of comprehension monitoring scored significantly higher ($p = .0149$) than the IVD lesson only group (adjusted means were 17.44 and 15.21 respectively). The hypothesis was accepted.

H_3: The teacher scaffolding only treatment group will have significantly higher adjusted posttest scores on the knowledge test than the comprehension monitoring only or IVD only groups. To test this hypothesis, two pre-planned comparisons (t-tests) were made between the teacher scaffolding only group, the comprehension monitoring only group, and the IVD lesson only group. This hypothesis was only partially supported. There was no significant group difference between the teacher scaffolding and comprehension monitoring groups ($p = .1589$) after the effects of the covariate were controlled. The adjusted means were 18.71 and 17.44 respectively. There was a significant difference between the teacher scaffolding only and the IVD only groups. The students who received the treatment of teacher scaffolding scored significantly higher ($p = .0002$) than the IVD lesson only group (adjusted means were 18.71 and 15.21 respectively).

H_4: The teacher scaffolding with comprehension monitoring treatment group will have significantly higher adjusted posttest scores on the knowledge test than will the teacher scaffolding only group, the comprehension monitoring only group, and the IVD only group. To test this hypothesis, three pre-planned comparisons (t-tests) were made between the teacher scaffolding only group, the comprehension monitoring only group, and the IVD lesson only group. Students who received the treatment of teacher scaffolding with comprehension monitoring scored significantly higher ($p = .0213$) than the teacher scaffolding only group (adjusted means were 20.90 and 18.71 respectively). In addition, they scored significantly higher ($p = .0004$) than did the comprehension monitoring only group (adjusted means were 20.90 and 17.44 respectively) and significantly higher ($p = .0001$) than the IVD lesson only group (adjusted means were 20.90 and 15.21 respectively). This hypothesis was accepted.

Table 5

Levels of Significance For Each Group

(n = 15 each group)

Group	Comprehension Monitoring	Teacher Scaffolding	Teacher Scaffolding/ Comprehension Monitoring
IVD Lesson	.0149	.0002	.0001
Comprehension Monitoring		.1589	.0004
Teacher Scaffolding			.0213

All hypotheses were confirmed with one exception. No differences were found between the treatments of teacher scaffolding only and comprehension monitoring only. However, for these two groups, the adjusted means were in the predicted direction (18.71 and 17.44 respectively).

CHAPTER V
DISCUSSION

The research described herein was designed to investigate the effectiveness of a multimedia/IVD for second graders in two areas. The first involved the unique properties of this technology as a stand-alone teaching tool. The second examined the non-technological strategies of teacher scaffolding and comprehension monitoring as supplements to IVD programs. Over the past 20 years, consistently small but positive learning outcomes have been registered for IVD applications across a wide variety of domains from military, private industry to professional training (Bosco, 1986; Bosco & Wagner, 1988; Browning et al., 1986; Evans, 1985; Hannafin; 1985; Hannafin & Colamaio, 1987; Hannafin & Phillips, 1987; Smith, 1987). Positive outcomes also were replicated in education settings for secondary and postsecondary students (Bosco, 1986; Cassidy, 1985; Evans, 1985; Dalton & Hannafin, 1987; Glenn et al., 1984; Hannafin & Colamaio, 1987; Russell et al., 1985; Thorkildsen & Friedman, 1984). Given that older children (9 - 12) have different cognitive capabilities than younger children (6 - 8), these findings could not be generalized to early elementary age populations. Four primary differences were identified (Bjorklund, 1989; Bjorklund et al., 1990). First, older children process information faster which enables them to focus on relevant information. For younger children, formal features, such as a high level of action or unusual sound effects, will capture attention whether or not this information is relevant to the lesson content. Second, older children have more refined strategies to use for integrating new information. Third, older children are aware of their memory strategies which promote better monitoring of progress. Fourth, older children have more knowledge about words and processes. Their framework on which to apply new information is more extensive. A larger knowledge base helps them to integrate new information quickly on a deeper level. For younger children, the multitude of inputs in IVD programs were considered to have the potential to overwhelm the child with irrelevant information. Research was needed to determine if multimedia/IVD could be a form that was too free of structure for the cognitively immature child.

Comprehension monitoring and teacher scaffolding have been found to bolster learning gains both in traditional classroom settings and with CBI programs. Typically young children do not use memory strategies which are available and known to them (Brown, Palincsar, & Armbruster, 1984; Baker & Anderson, 1982; Dewitz, Carr, & Patberg, 1987; Flavell et al., 1981; Harnishfeger & Bjorklund, 1990). This leads to a production deficiency in childrens' learning gains. Improvements were cited in reading, learning, and memory achievements for lessons which incorporated comprehension monitoring and teacher scaffolding techniques (Easton & Watson; Howe & O'Sullivan, 1990; Miller, 1984; Miller, 1990; Miller & Emihovich, 1986). For this study, these strategies were adapted for use with the multimedia/IVD program.

The goal of this research was to explore different ways of using multimedia/IVD applications to provide optimum learning gains for second grade children. The impact of these factors can make a significant contribution to the theoretical and applied areas of child development and educational technology.

Summary of Findings

A one-way analysis of variance (ANOVA) on pretest knowledge scores was used to examine whether subjects in the four treatment groups were equivalent at pretest. There was not a statistically significant difference in the pretest scores. It was concluded that the groups were equivalent in knowledge about apes and monkeys prior to the treatments. Four research questions were examined.

Research Question One

The first question addressed the issue of whether or not multimedia/IVD lesson was an effective instructional tool for second grade children. The hypothesis was tested with analysis of covariance. The independent variable was the treatment of the IVD lesson only. The covariate was the pretest knowledge score. The dependent measure was the adjusted posttest score.

H_1: The IVD lesson only group will have significantly higher adjusted knowledge test scores after controlling for preexisting differences.

Hypothesis One: Hypothesis #1 was accepted. Two characteristics determine if a medium's capabilities make a difference in learning: (1) how the components and presentation correspond to a particular learning situation, i.e., the tasks and learners involved, and (2) the way the medium's capabilities are used by the instructional design (Kozma, 1991). This finding supports previous CBI studies that early elementary-age children can easily operate within a computer workstation environment (Borgh & Dickerson, 1983; Muller, 1983; Rosen, 1982; Shade, Nida, Lipinski, & Watson, 1986; Swigger & Campbell, 1981). The primary hardware component the student had to manipulate was the computer mouse. All students without prior experience with a computer mouse (39% of sample) mastered the correspondence between moving the mouse on the desk and cursor position on the screen within 15-30 seconds.

Students also had to position the mouse cursor on the screen over an icon and press the mouse button to generate an "action" from the computer program, i.e., new text and narration occurred, new graphics or animation appeared, video segments began, etc. A variety of button presentations were incorporated into "Wise Lifty". Button formats included text highlighted in red, large graphics placed side by side across the screen and stacked vertically in groups of three, as well as smaller graphic/buttons along the bottom of the screen. The child could back up to prior information for review as well as go forward to the new information screens. The teachers reported that, after the child used each new arrangement of buttons the first time, he/she did not require continuous prompting. On average, three or fewer prompts were necessary after the initial orientation screens. This finding suggests that second graders can successfully use a variety of button positions - as long as they are consistently used for the same purpose throughout the program. For example, the submenus and question and answer screens used horizontally stacked buttons. Content screens used side by side placement. This finding suggests that the multiple buttons presentations, which are characteristic of the newer hypermedia programs, will be manageable for young children.

A second presentation component involved the use of two monitors for both computer and IVD inputs. Teacher reports noted that the children had no difficulty switching between presentations of text and graphics to video and back to text. Given that second graders have widely differing reading comprehension proficiency, one element which probably contributed to the success of this program was the voice-accompanied text. These multiple perceptual inputs probably contributed to overcome reading deficiencies.

This finding also addresses the Information Processing (IP) assumption that a young child may not have the ability to manage the flood of information which he/she constantly is experiencing in multimedia/IVD programs (Gay, Trumbull, & Mazur, 1991). Researchers have suggested that the multiple inputs of sound, color animation, and video segments might overwhelm the younger students. Younger students' attention tends to be captured by action and sound effects which may not have any connection with the construct or topic. This finding suggests that, with proper visual input and audio prompts, this technology increases learning outcomes.

Previous research on visual media, which registered that attention is positively captured by visual media, is supported by this outcome (Lorch, Anderson, & Levin, 1979). Studies have indicated that audiovisual presentations, especially with action and dialogue, that emphasized central content enhanced learning gains (Gibbons et al., 1986; Calvert et al., 1982). In addition, research findings cited that visual presentations are a highly facilitative instructional tool for young children (Razel & Bat-Sheva, 1990). In "Wise Lifty", the audio reinforcers which focused the child's attention on the salient video footage were another contributor to successfully using multiple media inputs. In sum, a multimedia/IVD tutorial science program can be developmentally appropriate to meet the physical, perceptual, and cognitive needs of young children.

Research Question Two

The second research question examined the contribution of comprehension monitoring as an effective supplemental strategy to multimedia/IVD programs for young children. One hypothesis was tested with analysis of covariance.

> H_2: The comprehension monitoring treatment group will have significantly higher adjusted knowledge test scores than will the IVD lesson only group.

Hypothesis Two. Hypothesis #2 was accepted. The four step comprehension monitoring strategy did enable the students to score significantly higher posttest scores when compared to the IVD only group. This finding supports the IP theoretical perspective that providing a child with a way to be more actively involved in the learning process will enable two changes to occur in his/her acquisition of metacognition. First, this enables the student to gain a method to organize new content within his/her current knowledge base. Second, the learner will be able to maintain and generalize the constructs and processes (Miller, 1990; Weinert & Perlmutter, 1989).

Information processing theorists also predicted that comprehension monitoring strategies would enable the child to move from effortful to automatic processing (Weinert & Perlmutter, 1989). Examinations of older children within the IP research perspective have illustrated that effortful processes are available to consciousness, yet interfere with other effortful processes being executed. With practice, they can be improved. Frequent use of monitoring allows effortful processes to become more automatic over time. The degree of success differs by individual differences in intelligence, motivation, and education. As processes become automatic, they are without conscious awareness, do not interfere with other processes being executed, and are not being affected by individual differences in intelligence. The trend for cognitive operations was hypothesized to consume a lot of effort initially with less mental effort being required with practice. IP researchers further hypothesized that understanding of subject matter would improve with comprehension monitoring techniques. These processes include rehearsal, chunking, i.e., grouping and linking like items though topics, prediction, question generation, summarization and clarification (Bjorklund et al., 1990; Flavell, 1979; Miller, 1990). Improvements in memory, reading comprehension, attention, communication, imitation and self-monitoring were cited as outcomes (Brown et al., 1984; Baker & Anderson, 1982; Dewitz et al., 1987; Flavell, et al., 1981; Harnishfeger & Bjorklund, 1990; Harris, et al., 1981). This finding suggests that comprehension monitoring enables young students to quickly build a framework that allows them to move from effortful to automatic processing and facilitates the essential skills of integrating new subjects and processes when using multimedia/IVD programs.

The significant increase in the comprehension monitoring group also supports prior findings in studies on text and stories, CBI, and multimedia/IVD technology (Baker & Anderson, 1982; Brown, Palincsar, & Armbruster, 1984; Dewitz, Carr, & Patberg, 1987; Flavell et al., 1981; Harris, et al., 1981; Howe & O'Sullivan, 1990; Miller, 1990; Patterson, et al., 1980). On task selection, young children typically give a disproportionate amount of attention to irrelevant information, ignoring the initial focus of a task to explore all the information presented. In addition, they are less likely to relate the new information to what they already know (Howe & O'Sullivan, 1990). Although K-2 students can not monitor their own comprehension with the same competency as middle grade students, they can successfully monitor their own comprehension when task demands are reduced (Miller, 1990). The finding indicates that incorporating comprehension monitoring techniques into multimedia/IVD formats produces positive outcomes in both recall and synthesis for second grade students.

One explanation for the success of this strategy might be the training procedure used. Intensive modeling and repetition of these four steps was executed on the practice day. The teacher modeled the steps on the first two lesson topics. Then the child worked with the teacher on the third and fourth constructs. Finally, the child used the steps alone on the fifth and sixth constructs. For the treatment program, the teacher again modeled and reviewed these steps on the initial screens to ensure that this facility had been retained. Nine constructs were selected for prompting, all of which were assessed in the test instrument. This finding demonstrates that a relatively short (30 - 40 minute) training process allows second grade students to master and generalize this technique in other subject areas using different processes (problem-solving and question and answer formats).

Research Question Three

The third research question examined if teacher scaffolding was an effective supplemental strategy to multimedia/IVD programs for young children. This hypothesis was tested with analysis of covariance.

H_3: The teacher scaffolding only treatment group will have significantly higher adjusted knowledge test scores than will the comprehension monitoring only or IVD only groups.

Hypothesis Three: Hypothesis #3 had two different outcomes. The comparison between the teacher scaffolding and comprehension monitoring groups was rejected while the comparison between the teacher scaffolding and IVD lesson only groups was accepted. The teacher scaffolding only group did not have significantly higher adjusted posttest scores than the comprehension monitoring group. From both theoretical and research perspectives, an explanation for this finding could be that these two variables incorporate the same basic processes, objectives, and goals. Both techniques involve generating an interactive process through dialogue (Bjorklund et al., 1990; Wood et al., 1979; Vygotsky, 1979). In teacher scaffolding, the interaction is initiated by the teacher to create dialogue with the student. In comprehension monitoring, that dialogue is an internal one within the learner only. Second, the objectives of both these strategies are to focus attention on the salient points in the lesson. Only the methods used to accomplish these objectives differ. With scaffolding, the teacher elicits reactions or responses from the student whenever a critical point or process occurs. Comprehension monitoring steps provide the framework within which the learner engages in self-debate through question generation, prediction, self-testing for understanding and recall (Baker & Brown, 1984; Flavell, 1979; Flavell et al., 1981; Levin & Pressley, 1981). Both strategies enable the learner to create both faster and more thorough recall and synthesis as he/she moves from relatively simple to more complex levels of thinking. Finally, the goals for each one are to enable children to construct novel methods of putting together new cognitive procedures.

This is an unexpected finding because the comprehension monitoring steps, which generally have more components for older children, were deliberately reduced to accommodate the cognitive level of the second grade child. A concern in reducing the steps was that they might not provide sufficient depth in helping the student to monitor their proficiency. Given that the interaction between the teacher and student in the scaffolding group was much more strenuous and detailed, one could argue that the monitoring steps were not thorough enough to produce a learning gain similar to scaffolding. The lack of significant difference between these groups suggests that the scaffolding interaction might have offered the students more information than was needed. While scaffolding created extra dialogue, the monitoring steps were just as effective. This outcome supports the strength of the multimedia/IVD as a teaching tool for the second grade student.

The second comparison in this hypothesis registered that the teacher scaffolding only group did have significantly higher posttest scores than the IVD only group. This outcome supports the Vygotskian concept of the effectiveness of processing information through social interactions between adults and children. Vygotsky proposed that adults act as mediators who are responsible for pacing a child's learning process (Vygotsky, 1979). The way a teacher explains events or processes is considered the central element in guiding a child's learning and producing positive learning outcomes.

From this viewpoint, an explanation for the significant finding in the scaffolding group could be in the teachers' high level of expertise and of experience. Effective teachers were critical as the child's learning level was assessed through a subjective judgment by the teacher. The choice of an appropriate level was based upon an intuitive estimate of the student's current performance. If that did not produce results, the teacher gradually adjusted the support until the child demonstrated that this was not needed. The cueing levels ranged from the least independent and most concrete, when the teacher assumed most of the leadership in the learning process (Level E), to the most independent and abstract level, when the student assumed most of the responsibility (Level A).

This finding also supports previous research which demonstrated that teacher scaffolding was an effective supplement to CBI (Brinkley & Watson, 1989/90; Easton & Watson, 1990; Fay & Mayer, 1987; Fay & Mayer, 1988; Markham, 1981; Miller & Emihovich, 1986; Pea & Kurkland, 1984; Solomon & Perkins, 1987; Nelson, Howard, Ingles, Wheatley-Heckman, Watson, 1988; Watson & Busch, 1990). Adapting teacher scaffolding to the menu driven program was problematic as the teacher lacked control over when material was presented. The metascript made the student's prior knowledge to topic selection unpredictable. A "metascript" was designed to help control this problem (Palincsar, 1986). This gave only a general format and guidelines in which scaffolded instruction could be framed rather than the specific "step" process as in comprehension monitoring. Given that the teacher scaffolding group registered higher knowledge scores than the IVD only group, these data suggest that experienced teachers can effectively use open-ended scaffolding scripts with multimedia/IVD lessons.

Research Question Four

Is the combination of teacher scaffolding with comprehension monitoring an effective supplemental strategy when combined with a multimedia/IVD program for second grade children? The hypothesis was tested with analysis of covariance.

> H_4: The teacher scaffolding with comprehension monitoring treatment group will have significantly higher adjusted knowledge test scores than will the teacher scaffolding only, the comprehension monitoring only, and the IVD only groups.

Hypothesis Four. Hypothesis #4 was accepted. The teacher scaffolding with comprehension monitoring group did register significantly higher posttest scores than the teacher scaffolding only, the comprehension monitoring only, or the IVD lesson only groups. An initial concern in designing this protocol was how to retain the comprehensiveness of both techniques without overwhelming the student with complex processes. This procedure began with the first two steps of comprehension monitoring, "What's the topic?" and "What's the question I'm trying to answer?". Then scaffolding was incorporated with an open-ended format during the "What do I need to remember?" and "What's the answer" phases. This design initially placed the learner in charge of establishing the framework for question generation and recall. The teacher generated dialogue after accessing the student's level of comprehension in response to the student's responses on the salient points of a topic. Thus, the teacher lead the way through the processes of analysis and synthesis.

This finding supports research studies which indicate that learning environments, which stimulate carefully planned, conscious thinking, can produce learning gains, even in novel situations (Flavell, 1979). Students are thought to be more likely to initiate, sustain, direct, and actively involve themselves in a learning setting when they believe success or failure is due to factors within their control. This outcome suggests that placing the initial responsibility with the learner and, then, adding teacher supports allow the student to more effectively identify relationships between new and existing knowledge. These data again support both the Vygotskian and IP hypotheses that adult mediated and self-monitored learning produce frameworks which promote automation, the building of associations, and the generation of meaning and synthesis. These data indicate that combining these two strategies provided the child with multiple learning, monitoring, and synthesizing techniques which increased learning gains when using multimedia/IVD instruction.

Conclusions

The goal of this study was to explore age appropriate uses of a second grade multimedia/IVD science lesson in two areas. First, the unique properties that these media offer were assessed as a stand-alone teaching tool. The IVD only group registered significantly higher adjusted posttest scores after navigating the multimedia/IVD lesson. Previous research indicates that the more closely a media's components and presentation match the tasks and learners involved, the more positive the learning outcomes are (Kozma, 1991). The tasks and presentations in the multimedia/IVD lesson involved manipulating a mouse, using a variety of button formats, and processing multiple perceptual inputs from both a computer and IVD monitor. Students without prior experience quickly mastered the correspondence between the computer mouse and the cursor symbol on the computer screen.

Previous research findings also indicated that multiple button formats might be too confusing for a young child (Gay, Mazur, & Trumbull, 1991). In the treatment program, button formats included highlighted text, and large and small graphics in horizontal and vertical arrangements. These data suggest buttons which display graphic depictions of lesson constructs allow young children to travel with comfort through relatively large bodies of imagery-based information.

Prior research also indicated that young children's attention tends to be attracted by action and sound effects which may not relate to the salient information of the lesson. "Wise Lifty's Primates" was carefully designed with text, graphic, and audio prompts to guide the learner's attention to the relevant information presented, especially during the video sequences. Audio reinforcers detailed the salient information during each video display. This finding indicates that the careful, consistent use of orienting cues can lead to learning gains. Thus, a properly designed multimedia/IVD program can be developmentally appropriate to meet the physical, perceptual, and cognitive needs of the young child.

The second area examined in this study involved the non-technological supplements of comprehension monitoring and teacher scaffolding used separately and in combination with a multimedia/IVD program. Each of these groups registered higher posttest scores than the IVD only group. This finding supports two Information Processing assumptions. First, the monitoring of comprehension aids a child without that facility to move from effortful to automatic processing. Automation was thought to provide a way to organize new content within a learner's knowledge base. The organized knowledge establishes the framework through which constructs and processes could be generalized to other subject areas. This outcome indicates that second graders can master and generalize comprehension monitoring techniques to other subject areas requiring different processing skills (factual to problem-solving through question and answer formats) when using multimedia/IVD programs.

Even though the teacher scaffolding and comprehension monitoring groups had made significantly higher posttest scores when compared to the IVD lesson only, they were statistically equivalent when the adjusted posttest scores were computed. From both a theoretical and research perspective, a possible explanation for this outcome is that both strategies are thought to incorporate the same basic properties. Both activate an interactive process through dialogue. Both have the objective of creating faster and more thorough recall and synthesis by aiding the student to progress from relatively simple to more complex levels of thinking. Both have the goal of providing the essential methods necessary for forming new cognitive procedures. These data suggest that supplemental teaching/learning strategies, either externally or internally generated, facilitate the process of learning with a multimedia/IVD lesson.

The teacher scaffolding with comprehension monitoring group scored significantly higher posttest scores than the groups which used these strategies separately. This outcome supports both the Vygotskian and IP hypotheses that teacher mediated and self-monitored learning promotes automation, the building of associations, and the generation of meaning and synthesis. In addition, this finding suggests that combining these two strategies in age appropriate formats empowers the child with multiple learning, monitoring, and synthesizing techniques when using multimedia/IVD instruction.

In sum, these findings illustrate that a carefully designed multimedia/IVD lesson can produce learning increases for second grade students. Both teacher scaffolding and comprehension monitoring are effective techniques to allow students to comprehend and learn better in technology based educational settings. A combination of externally generated guidance with an internally focused cognitive monitoring provides maximum learning benefits with multimedia/IVD programs.

Limitations

A limitation to this study was the relatively small sample size (N=15) for each treatment group. The results of this study are generalizable only to second grade students in schools with similar demographic and geographic characteristics. The presence of the teacher in the comprehension monitoring treatment may have caused the students to be more diligent. In a "real world" situation, students without such close teacher presence may show different outcomes.

Recommendations for Future Research

Imagery based computer instruction is predicted to have a major impact on educational curriculum in the next century. Yet, research on the effectiveness of current imagery technology for early elementary-age children remains sparse. These findings suggest that future instructional designers should continue to develop highly visual and interactive programs for young children. More exploration into the effectiveness of multiple button formats is needed to prepare for the navigational problems that index accessed hypermedia programs will present.

These findings further suggest that future research efforts might also focus on early elementary students' underlying thought processes while using imagery based computer instruction. Learning gains seem likely to depend on the direction and intensity of the students' attention to the differing aspects of multimedia inputs. These findings suggest that the more comprehensively the students were focused on the learning content, the greater were the learning outcomes. Further studies might focus of the depth of involvement or "mindfulness" a young child can use in processing multiple perceptual inputs common to imagery systems.

These findings also suggest that future research might continue investigating the process of supplemental instruction during technology based curriculum. Different teacher scaffolding models could be explored to determine which provides the most effective learning outcomes. Studies which measure the impact of increasing or decreasing the amount of scaffolded dialogue would contribute to our understanding of this process. Applying a variety of successful teaching models could lead to even greater learning productivity for early elementary-age students using imagery system applications.

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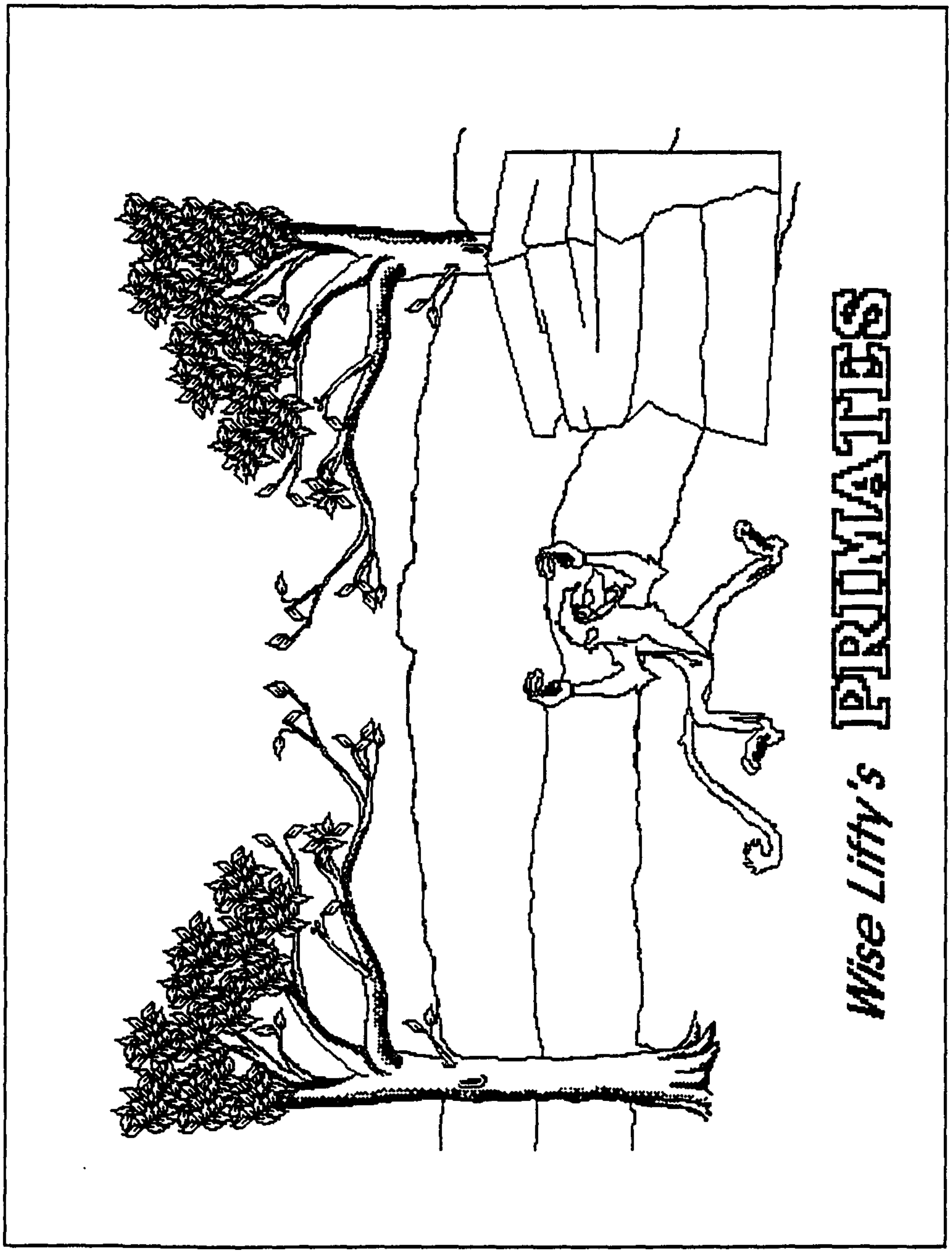
APPENDIX A

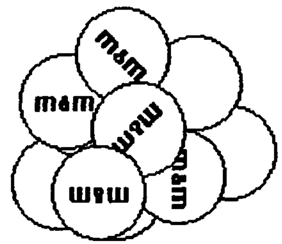
INFORMATION PROCESSING MODEL

APPENDIX B

"WISE LIFTY'S PRIMATES"

INTRODUCTION AND DEFINITION EXAMPLES


Wise Lifty's PRIMATES



If you were classifying candy, you would say M&M's and Skittles are alike because they are small, round candies. This is **comparing**.

But also, M&M's and Skittles are different because M&M's have chocolate and Skittles don't. This is **contrasting**.

See - now you are thinking like a scientist, too!

APPENDIX C

"WISE LIFTY'S PRIMATES"

ALIKE AND DIFFERENT EXAMPLES

Let's look at the ways apes and monkeys are

Alike

Different

Let's look at the ways apes and monkeys are alike

What they eat

How their hands and feet look and work

How their arms look and work

Let's look at the ways apes and monkeys are different

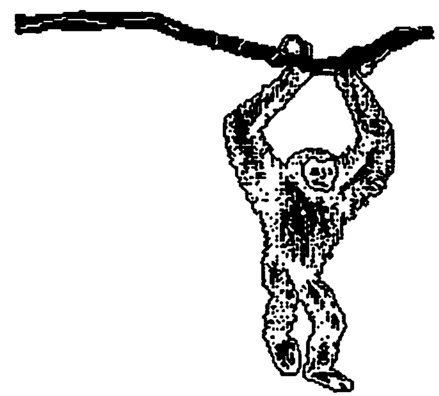
Rears - how they look

Noses - how they look

Locomotion - how they move

How their locomotion is different.

Apes use their long arms to help them swing from tree to tree. This is called brachiation (BRAY - kee - A - shun).



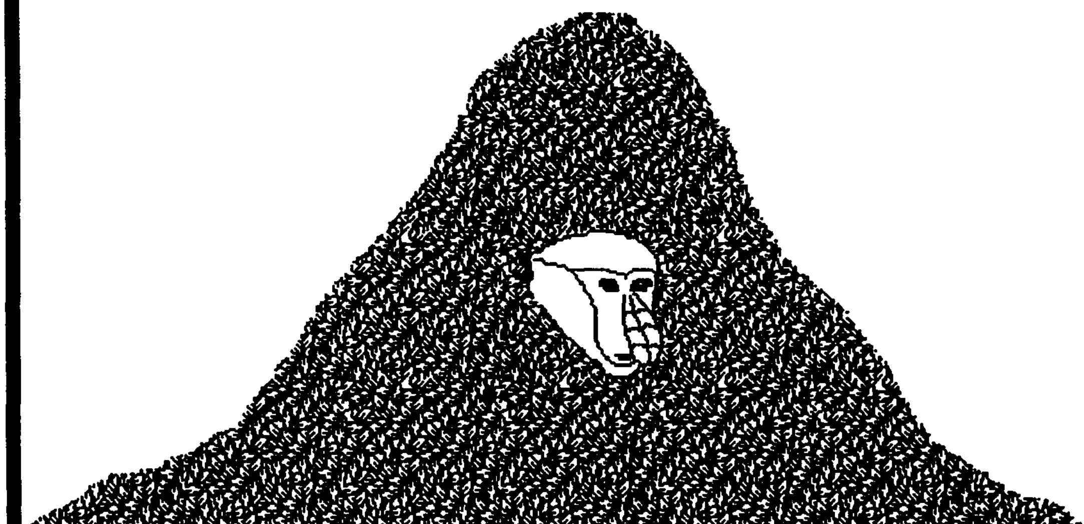
APPENDIX D

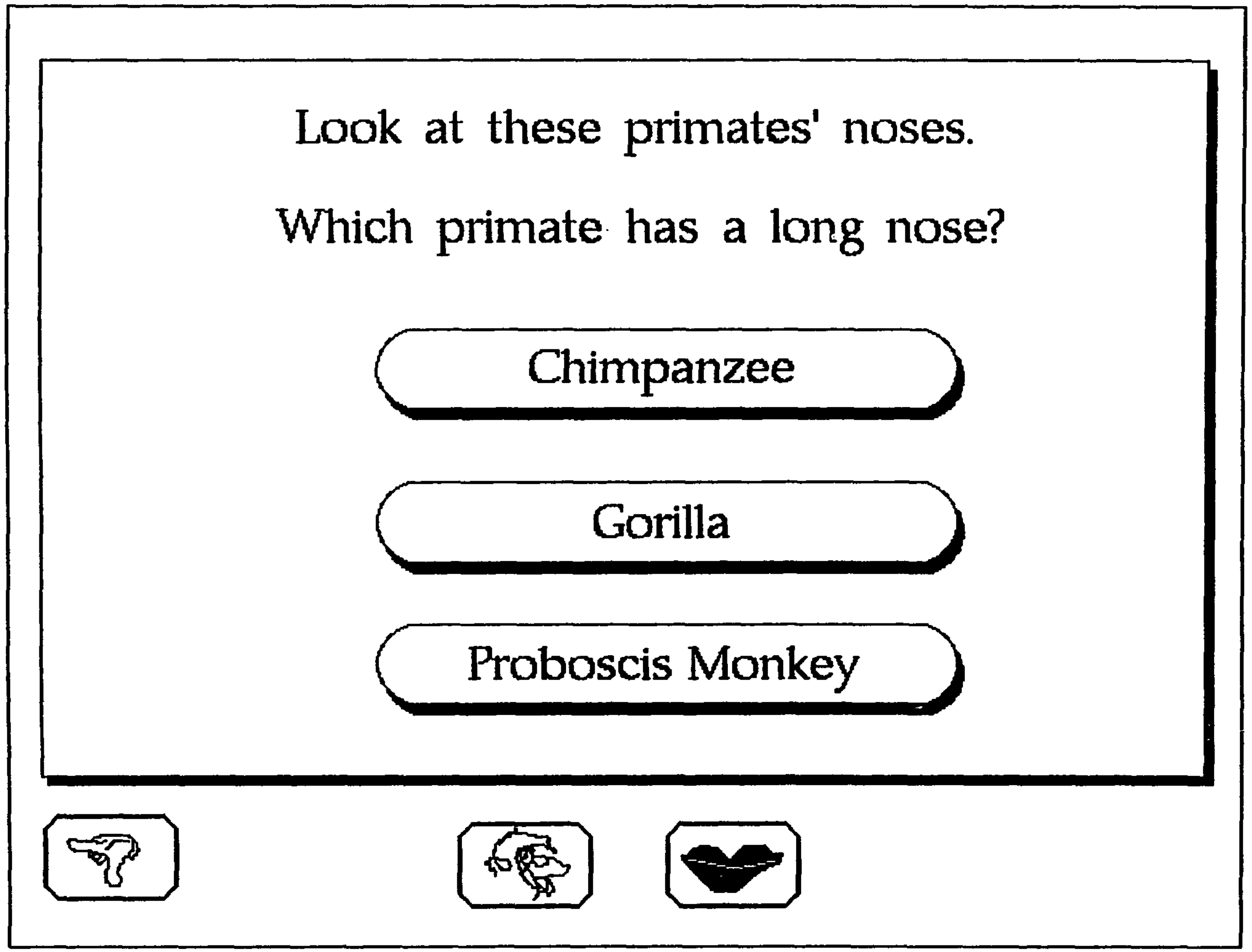
"WISE LIFTY'S PRIMATES"

PROBLEM-SOLVING EXAMPLES

What a sight! It has a funny nose

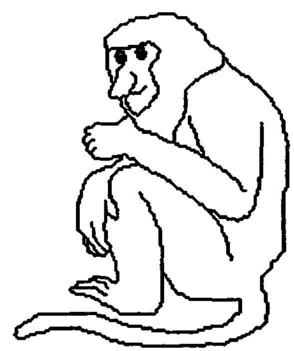
that wobbles!




Look at these primates' noses.
Which primate has a long nose?
Chimpanzee
Gorilla
Proboscis Monkey

Good thinking! It's the nose

of the Proboscis Monkey.



What an adventure this has been for you!

Now you see, by comparing and contrasting the primates, you helped me solve the problems.

APPENDIX E

TEST CONSTRUCTION QUESTIONS

Practice question:

1. A dog has
   a. legs
   b. wings
   c. fins

Answer Sheet - Practice Question

1. a b c

---

1. Primates are
   a. cold-blooded animals
   b. warm-blooded animals
   c. a kind of insect with no blood

2. Primates live
   a. only in America
   b. mostly in Africa
   c. all over the world

3. The group of animals called primates is made up of
   a. only monkeys and apes
   b. monkeys, apes and some other animals
   c. all monkeys, but only some kinds of apes

4. The group of animals called primates has
   a. many animals in it
   b. only monkeys in it
   c. only apes and monkeys in it

5. Apes and monkeys are
   a. alike in all ways
   b. different in all ways
   c. alike in some ways and different in others

6. Locomotion tells about:
   a. where something is
   b. how something acts
   c. how something moves

7. Grasshoppers and termites are food for
   a. monkeys only
   b. apes only
   c. both apes and monkeys

8. Chimpanzees are apes with flat noses like a
   a. gorilla's
   b. guereza's
   c. baboon's

9. Which of the following primate has a tail?
   a. a chimpanzee
   b. a guereza
   c. a gibbon

10. The langur is a monkey. It moves through the trees like the
   a. orangutan
   b. guereza
   c. gibbon

11. The rears of the orangutan and the gorilla
   a. are alike
   b. are different
   c. both have long slender tails

12. The proboscis monkey has a

a. long nose
b. flat nose
c. nose with wide openings

13. The chimpanzee is an ape. The ________ also is an ape.
    a. red uakari
    b. ring-tailed lemur
    c. orangutan

14. Grouping things by how they are alike and different is
    a. not very scientific
    b. called justification
    c. called classification

15. When you classify, you
    a. tell how things are the same and different
    b. tell how things are the same
    c. teach apes to do new things

16. Comparing means
    a. telling how things are the same
    b. telling how things are different
    c. telling how things are the same and different

17. Contrasting means
    a. telling how things are the same
    b. telling how things are different
    c. telling how things are the same and different

Do you agree or disagree?

A = Agree D = Disagree

18. The things apes and monkeys eat are berries and fruit, leaves and stems.

A = Agree D = Disagree

19. Both apes and monkeys eat grasshoppers.

A = Agree D = Disagree

20. Apes and monkeys have different kinds of arms and legs.

A = Agree D = Disagree

21. Monkeys do not have hands that can grab.

A = Agree D = Disagree

22. Monkeys have noses with wide, flat openings.

A = Agree D = Disagree

23. Apes' noses have larger openings than monkeys' noses.

A = Agree D = Disagree

24. Apes have noses that are long and skinny.

A = Agree D = Disagree

25. Monkeys have noses with small openings.

A = Agree D = Disagree

26. Both monkeys and apes have tails.

A = Agree D = Disagree

27. Monkeys like to walk on their knuckles.

A = Agree D = Disagree

28. Apes move through trees by swinging their arms and legs.

A = Agree D = Disagree

29. Apes and monkeys are kinds of primates.

A = Agree D = Disagree

30. Primates are an example of a type of monkey.

A = Agree D = Disagree

31. All primates live in Africa.

A = Agree D = Disagree

32. Another name for a monkey is an ape.

A = Agree D = Disagree

33. Monkeys are small apes.

A = Agree D = Disagree

34. The lar gibbon swings from tree to tree.

A = Agree D = Disagree

35. The red uakari eats leaves.

A = Agree D = Disagree

36. The proboscis monkey has a flat nose.

A = Agree D = Disagree

37. Orangutans have tails.

A = Agree D = Disagree

38. A proboscis monkey is really an ape.

A = Agree D = Disagree

Are the things named in the sentence
"Alike" or "Different"?

39. The food that monkeys and apes eat is:

A = Alike D = Different

40. Ape and monkey hands and feet look:

A = Alike D = Different

41. Ape and monkey noses look:

A = Alike D = Different

42. Ape and monkey hands and feet work:

A = Alike D = Different

43. The way that ape and monkey arms and feet work is:

A = Alike D = Different

44. The way that apes and monkeys move through the trees is:

A = Alike D = Different

45. The way that apes and monkeys locomote is:

A = Alike D = Different

46. The way that apes and monkeys look from the back is:

A = Alike D = Different

47. The places where apes and monkeys live are:

A = Alike D = Different

48. The way that apes and monkeys hold onto branches is:

A = Alike D = Different

49. The way that apes and monkeys walk on the ground is:

A = Alike D = Different

50. The way that ape and monkey fingers look is:

A = Alike D = Different

51. The rears of the ring-tailed lemur and the gorilla are:

A = Alike D = Different

52. The way that a chimpanzee and a proboscis monkey move among trees is:

A = Alike D = Different

53. The noses of the chimpanzee and the gorilla are:

A = Alike D = Different

54. The things that uakaris and chimpanzees eat are:

A = Alike D = Different

These animals are either an ape or a monkey.
Circle A = Ape or M = Monkey

62. Gorilla A = Ape or M = Monkey

63. Orangutan A = Ape or M = Monkey

64. Baboon A = Ape or M = Monkey

65. Ring-tailed lemur A = Ape or M = Monkey

66. Chimpanzee A = Ape or M = Monkey

67 Lar Gibbon A = Ape or M = Monkey

68. Guereza A = Ape or M = Monkey

69. Proboscis Monkey A = Ape or M = Monkey

70. John is sorting his clothes.
He puts is shorts in the same drawer as his socks.

John is **comparing** or **contrasting** his shorts and socks?

71. Dad decides to clean up the garage. He stacks the boxes of nails away from the cans of paint.

Is Dad **comparing** or **contrasting** the nails and the paint?

72. Grandma looks for worms in both her tomato and bean plants.
Is Grandma **comparing** or **contrasting** the tomatoes and bean plants?

73. Grandpa picks up two boxes of cookies at the grocery store. He sees that one kind has marshmallow filling. The other kind has cream filling.

Is Grandpa **comparing** or **contrasting** the cookies?

74. Ms.Taylor asks Tommy to put the same color blocks in one box.

Will Tommy be **comparing** or **contrasting** the blocks?

75. Which sentence shows Jimmy using classification?

a. Jimmy pours water into different sized containers.
b. Jimmy puts rocks into piles of smooth or rough rocks.
c. Jimmy makes the same marks on pieces of tree bark.

76. You're looking at 2 pieces of pizza. You choose the one with cheese instead of sausage.

You are:
a. comparing the pizzas
b. contrasting the pizzas
c. dividing the pizzas

77. Which sentence shows Mary comparing items?

a. Mary picks out a red ribbon for her red dress.

b. Mary picks out rocks from a basket of rubber balls.

c. Mary lines up blocks from the shortest to the longest.

78. Your mother wants you to clean up your room. You look into your sister's room to see if she is cleaning too.

You are
a. comparing
b. contrasting
c. planning

79. You see a tape you like on the shelf. You look to see if there are more copies of the same tape.

You are
a. comparing
b. contrasting
c. wishing

APPENDIX F

INFORMED CONSENT LETTER AND FORM:

TEST CONSTRUCTION

The University of North Carolina at Greensboro
Department of Human Development and Family Studies
April 21, 1993

D-4 Park Building
Greensboro, N.C. 27412-5001
(919) 334-5307

Dear Parent/Guardian:

Your child is invited to participate in a study which will examine different ways of using state-of-the-art computer-based instructional technology, called multimedia/interactive videodisc. A videodisc can be thought of as a phonograph record which uses a beam of light for playback instead of a needle. In addition to sound, the videodisc shows still and moving pictures on a television monitor. The program also presents graphics, animation, and text on a computer monitor. In addition, an audio sequence reads the text which is displayed on the screen.

This study will provide an opportunity for your child to experience an instructional lesson on primates. The children will be randomly assigned to either one of two groups. The first will use the lesson individually and the second as a group. Your child does not need prior computer or keyboard skills as we will assist in demonstrating this easy to use, mouse operated program.

In no way will your response to this letter or the information received from this study affect your child's grade or standing in school. All scores are kept confidential and destroyed at the conclusion of the study effort.

Please indicate whether or not your child may participate in this study. If you indicate that your child may participate and later reconsider, or if your child wants to stop participation during the study, she/he may do so. Also, on the same form, indicate if you wish to receive a group summary of the results by checking the box at the bottom.

Thank you for your consideration.

Sincerely,

Jane K. Ching, M.S.
Carole S. Nelson, M.S.

Please return this form to the school tomorrow

Parent/Guardian's Permission Form

Name of child: ____________________________________

______ My child has permission to participate in this study.

______ My child may not participate in this study.

____
Signature - Relationship

____
Date

Your child can withdraw from the study at any point in time without penalty. Non-participation in the study will in no way affect the status of your child in the class or school. Data will be numerically coded, kept confidential and destroyed at the conclusion of the study.

|_| I wish to receive a group summary of the results, which will be available in the school at the beginning of the next school year.

APPENDIX G

PRETEST AND POSTTEST COMPUTER PROGRAM

Enter Student's ID Code

OK

1. The proboscis monkey has a

a. long nose
b. flat nose
c. nose with wide openings
d. I don't know

2. Grouping things by how they are alike and different is

a. not very scientific
b. called justification
c. called classification
d. I don't know

3. Primates are

a. cold-blooded animals
b. warm-blooded animals
c. a kind of insect with no blood
d. I don't know

4. Apes and monkeys are

a. alike in all ways
b. different in all ways
c. alike in some ways and different in others
d. I don't know

5. Locomotion means

a. where something is
b. how something acts
c. how something moves
d. I don't know

6. Chimpanzees are apes with flat noses like a

a. gorilla's
b. guereza's
c. baboon's
d. I don't know

7. The hanuman langur is a monkey. It moves like the

a. orangutan
b. guereza
c. gibbon
d. I don't know

8. When you classify, you

a. tell how things are the same and different
b. tell how things are the same
c. teach apes to do new things
d. I don't know

9. Both monkeys and apes ha
tails.

Agree Disagree

I don't know

10. Monkeys like to walk on
on their knuckles.

Agree Disagree

I don't know

11. Apes have noses that are
long and skinny.

Agree Disagree

I don't know

12. Monkeys have noses with
wide, flat openings.

Agree Disagree

I don't know

13. Orangutans have tails.

Agree Disagree

I don't know

14. The probosics monkey has a
flat nose.

Agree Disagree

I don't know

15. Apes and monkeys are kinds of primates.

Agree Disagree

I don't know

16. A proboscis monkey is really an ape.

Agree Disagree

I don't know

17. Ape and monkey noses look

Alike Different

I don't know

18. The way that apes and monkeys move through the trees is

Alike Different

I don't know

19. The way that apes and monkeys locomote is

Alike Different

I don't know

20. The way that apes and monkeys look from the rear is

Alike Different

I don't know

21. The rears of the ring-tailed lemur and the gorilla are

Alike Different

I don't know

22. Is this

An Ape A Monkey

I don't know

23. Some things apes and monkeys eat are leaves, grasshoppers, and termites.

Agree Disagree

I don't know

24. The orangutan is

An ape A monkey

I don't know

25. The ring-tailed lemur is

An ape A monkey

I don't know

Good work!

Thank you

and

Good bye from your friend, Lifty.

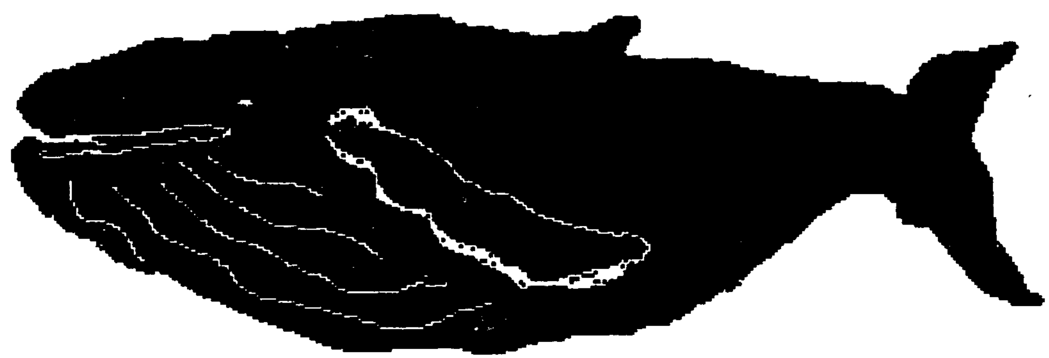
APPENDIX H

MULTIMEDIA/IVD PRACTICE LESSON

"SEA MAMMALS"

Sea Mammals

© J. Allen Watson 1988



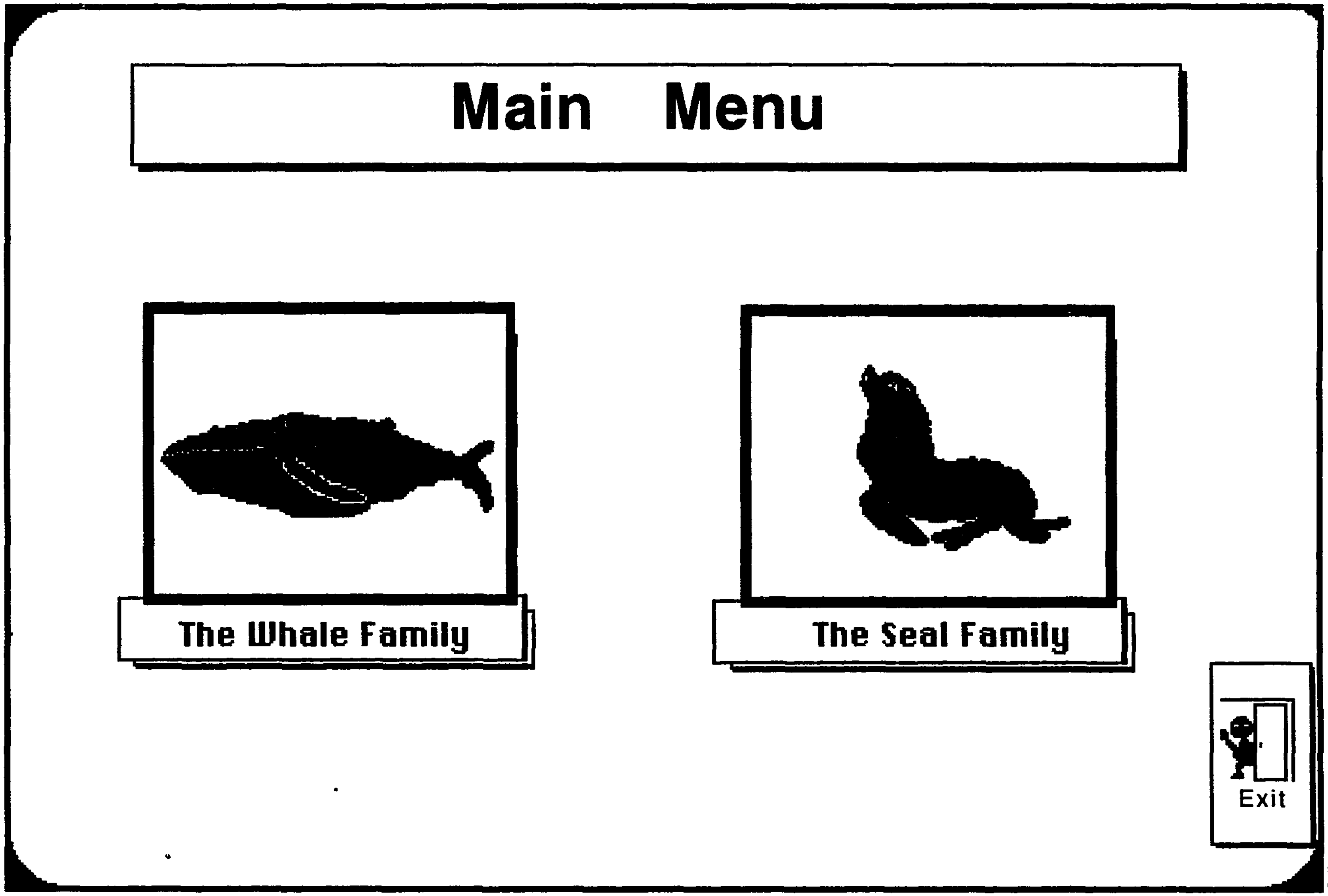
About sea mammals

There are two kinds of mammals - land mammals and sea mammals.

Some live on the land such as dogs and cats, bears and pandas. These are called land mammals. Here is a picture of a panda who lives on land.

About sea mammals

The other kind of mammals are called sea mammals. Some sea mammals need to be both on land and in the water to live. These mammals are members of the seal family. Here is a picture of a seal.


Main Menu
The Whale Family
The Seal Family
Exit

The Whale Family

click in the box you want to see - checked when completed

✓ where they live

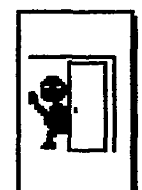
✓ how they breathe

✓ the smallest

✓ how they move

✓ the largest

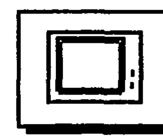
✓ about the babies



Where do they live?

There are two members of the whale family. They are called dolphins and whales. Their home is in the water.

They live in the seas and oceans all over the world. This video shows whales swimming in their home waters.



The largest family member

The largest member of the whale family is the blue whale. Blue whales are bigger than elephants. They are even bigger than the huge dinasours who lived millions of years ago. In fact, it is the largest mammal ever known to have lived.

APPENDIX I

INFORMED CONSENT LETTER AND FORM:

TREATMENT

Dear Parent/Guardian:

Your child is invited to experience state-of-the-art computer and laserdisc technology! All second grade students in Southwest Elementary School are being offered two multimedia/interactive videodisc instructional lessons. One lesson explores the world of whales or seals and the second compares and contrasts the world of apes and monkeys. These lessons are being offered as part of a study designed to evaluate if students do as well when they are using this technology alone as they do when they have training to monitor their progress and/or with teacher interaction.

Your child does not need prior computer or keyboard skills as we will assist in demonstrating these easy to use, mouse operated programs. All text is read to the student through the computer program so that reading ability will not effect the student's enjoyment of the program. These lessons will involve your child for a total time of approximately 45 minutes during two days. Children who wish to be in this study will be randomly assigned to one of the four study groups.

In no way will your response to this letter or the information received from this study affect your child's grade or standing in school. Only one lesson will have questions with it and the scores on this test are kept confidential and destroyed at the conclusion of the study effort. Only group results are calculated for analysis and used for the study.

Please indicate whether or not your child may participate in this study. If you indicate that your child may participate and later reconsider, or if your child wants to stop participation during the study, she/he may do so.

Thank you for your consideration.

Sincerely,

Carole S. Nelson, M.S.

cc: Mr. James Battle

Please return this form to Southwest Elementary tomorrow

Parent/Guardian's Permission Form

Name of child: ____________________________________

______ My child has permission to participate in this study.

______ My child may not participate in this study.

____
Signature - Relationship

____
Date

Your child can withdraw from the study at any point in time without penalty. Non-participation in the study will in no way affect the status of your child in the class or school. Data will be numerically coded, kept confidential and destroyed at the conclusion of the study.

|_| I wish to receive a group summary of the results, which will be available in the school at the beginning of the next school year.

APPENDIX J

PROTOCOL FOR INTRODUCTION TO EQUIPMENT AND PRETEST

Protocol for Introduction to Equipment and Pretest

The following guidelines are to be used for introducing the child to the hardware and software.

While walking the child from his/her classroom, ask if he/she has ever used the computer before so you'll know the level of the child's prior experience.

Once you're seated at the workstation, begin the session by saying: "As your teacher told you, we'll be using a special kind of computer program today." Point out and identify computer screen and videodisc player monitors.

Then ask: "Have you used this type of computer mouse before?"

(If no -)

I'll show you a few things first. Instead of using the keyboard to make things happen on the computer screen, we can use this mouse. First, you need to know how to hold the mouse. Are you right or left handed? (position the mouse accordingly.) Hold the mouse like this with the cable pointing away from you. The square block on the mouse is called the mouse button. Put at least 1 finger on the mouse button.

When you move your mouse, the pointer will move on the screen. **(Demonstrate making a circle on the screen.)** Move the mouse around now. Watch what happens on the screen.

(If yes and shows ease with mouse)

Now, we're going to show you some information on apes and monkeys. Here is a question and some choices. The monkey in the corner is named "Lifty". He will tell you each question and pronounce each answer. If you want to hear the question repeated, click on Lifty's head. Try it now by pressing on the mouse button. To hear the choices, click on each one of them. Try this.

OK. The first question is " The proboscis monkey has a..." Whatever you think the answer is, is fine. Which is your choice? Now, when you've made your choice, you can move the pointer to the hand to go to the next question.

You can put these headphones on so only you can hear the sound **(plug them in)**.

APPENDIX K

PROTOCOL FOR "SEA MAMMALS"

Introduction to Practice Multimedia/IVD Lesson

"Sea Mammals"

When child finishes the pretest, clicking on the hand will open the "Sea Mammals" program .

Now, we're going to use both the television monitor to the computer as we look at some information about sea mammals. Put the pointer on the hand, click once, and count slowly to three. One...Two...Three **(Program will begin)**. Read all text to child and verbally reinforce the information on the video monitor with the appropriate text.

After the introductory information, the whale and seal menu will appear.

Now, you can learn more information on either whales or seals. Which would you like to learn more about? (Then instruct the child to place the pointer on the appropriate graphic.)

After completing the program, write in the child's name on the appropriate certificate, sign, date, and give sticker.

Certificate of Achievement

Student's Name

who completed the multimedia/interactive videodisc program on:

The Whale Family

where they live	how they move
the smallest	how they breathe
the largest	about the babies

Teacher's Signature

Date

Certificate of Achievement

____
Student's Name

who completed the multimedia/interactive videodisc program on:

The Seal Family

where they live	how they move
the smallest	how they breathe
the largest	about the babies

____
Teacher's Signature

____
Date

APPENDIX L

PROTOCOL FOR "WISE LIFTY'S PRIMATES"

Introduction to Multimedia/IVD Lesson

"Wise Lifty's Primates"

Computer will be set to the beginning screen with the text reading *"Hi! I am Wise Lifty and I live in the jungle. I need your help little friend!"*

Begin session by identifying the new subject areas. "Today, we're going to use a program similar to the one on whales and seals. But this time, the information is on apes and monkeys. Wise Lifty is personally going to take us on this tour through the jungle."

Ask child to click on the lips, so that the text is repeated. Then, identify the purpose of the hand icon by saying: "The pointing hand lets you go on to the next screen. Ready to see what's next?"

The text will read *"A new group of primates came into the jungle today. You have to tell me what kind they are, so I can send them to their friends."*

The only explanation needed on this screen is to identify the hand pointing to the left. Say: "If you want to see the screen we were just on once more, use this button. But if you want to see new information, keep on using the button on the right."

The third screen has a *"magic button to help you...hear the words again. Try it now."* Guide the child in using this button. Then prompt to use the hand pointing to the right.

A new type of screen follows this. The text is *"Primates are a group of warm-blooded animals that live all over the world..."*

Note to the child that there is not a button with a hand on the bottom of the screen. There are words in red. Those are the "hot" spots. Prompt child to "click" on any of the words in red. Track each choice made so that the child does not repeat a word accidentally. But if the child indicates that he/she would like to see a selection again, let him/her know that's possible by clicking on it again. This is true for all buttons that follow in the program. The hand in the right corner will not appear until all three words in red have been selected.

For the screens that appear when "apes" or "monkeys" is chosen, note again that no hand is in the right corner. Prompt child to click on one of the animal names in the rectangles.

After the first selection, explain to the child that the check lets him/her know that they've covered that choice. But that they may look at it again even when it's checked.

After these screens are completed, Ask if any questions. and instruct the child to work on their own. But that you will help at any point that things are unclear.

Problems section. The program defines the "Lifty" button. Explain this button again once a question is posed"Lifty" and the "Lifty" button appears, i.e., if they know the answer to the question, they should click on this button to get the screen to answer on.

After completing the program, write in the child's name on the appropriate certificate, sign, date, and give sticker.

Certificate of Recognition
to

____

Student's Name

who completed the multimedia/interactive videodisc program on:

Apes — Monkeys

Alike	Different
things they eat	how noses look
hands and feet	if they have tails
use of arms	in locomotion (how move)

Lifty's "help me" problems

____

Teacher's Signature/Date

APPENDIX M

PROTOCOL FOR COMPREHENSION MONITORING

Protocol for Comprehension Monitoring Training

"Sea Mammals"

Use regular introduction to "Sea Mammals" through first four frames. After the student has selected either whales or seals, start with this procedure beginning on either whale or seal construct menu: Introduce the comprehension monitoring steps card to the student by saying: " Wise Lifty also has some secret ways that will help you to remember information. You need to keep in mind each of these four questions as we look at each of these areas of information. Which area do you want to look at first?"

Still on menu screen:

Step 1: Identification of subject: On the construct menu, the child is instructed to select a topic and answer "What's the topic?"

Step 2: Rephrasing in question form: Next, the child is instructed to turn the subject into a question by asking and answering: "What's the question I'm trying to answer?"

On information screen(s):

Step 3: Selecting the key phrases and rehearsal: After reading and listening to the text, looking at the graphic and/or video, the child next asks "What do I need to remember?" This allows the child to rehearse the salient points.

Step 4: Recall: The child then responds to the question "What's the answer?"

Phases for Implementing Comprehension Monitoring Steps With Practice Lesson

Phase 1: The teacher models the comprehension monitoring steps for the child during the first and second constructs.

Phase 2: The teacher and the child use the steps together for the third construct.

Phase 3: The teacher then instructs the child to whisper the statements alone when selecting the fourth construct.

Phase 4: The teacher instructs the child to repeat the steps silently for the fifth and sixth constructs while pointing to the steps as they are used. After completing each one of these, the teacher asks the child to give the answer. If an incorrect response is made, the teacher goes through the steps with the child to determine which were unclear or omitted, repeat and review the steps.

Lifty's Winning Ways

Ask and Answer:

1. What's the topic?
2. What's the question I'm trying to answer?
3. What do I need to remember?
4. What's the answer?

Protocol for Comprehension Monitoring

"Wise Lifty"

Use regular introduction to "Lifty" by identifying the navigation buttons through classification screen. If student appears uncomfortable or unfamiliar with steps, review them until student has reached his/her level of use displayed on practice lesson.

On comparing screen, say:
"Here are the 4 questions we used to help remember the information in yesterday's program on Sea Mammals? We are going to use them again today. Let's go over how they work. To use them to help us remember what comparing is, we would say: The topic is comparing. The question is What is comparing? I need to remember that comparing is knowing how things are alike. The answer is we can compare M&M's and Skittles because they both are round candies."

On contrasting screen, say "To use these steps to help us remember what contrasting is, we would say: The topic is contrasting. The question is "What is contrasting?" I need to remember that contrasting is knowing how things are different. The answer is that we can contrast M&M's and Skittles because M&M's are chocolate but Skittles are not."

On "Alike and Different menu" - say, I will point to the steps on 4 topics during the lesson. When I do this, use these steps then you are listening and looking at the information in those topics. But you don't need to tell me the answer. Answer them silently to yourself."

On the "Alike" menu:
prompt when child selects the "What they eat" topic.

On the "Different" menu:
prompt on each of the three topics.

Use standard introduction to **Problems section** and ask child to use the steps on each problem.

APPENDIX N

PROTOCOL FOR TEACHER SCAFFOLDING

Protocol for Teacher Scaffolding

The following information explains the process of teacher scaffolding. Scaffolding applies to one-to-one interactions in which an expert supplies the level of support that the learner needs to succeed in a learning task. Success is defined when independence in the learning process is achieved. This model, called contingent scaffolded instruction, establishes a pattern of direct instruction in which the teacher gradually releases responsibility of the teaching as the learner becomes more proficient. In general, the process moves from modeling, to guided practice and, finally, to independent practice.

Scaffolding is defined by the level of "abstractness" the teacher uses to foster learning. Appropriate levels are selected systematically in response to the student's performance. The teacher chooses the appropriate level of cueing based upon an intuitive estimate of the student's current performance. If that does not produce results, the teacher gradually adjusts the support and provides direction through assuming more responsibility until the child demonstrates that this is not needed.

The cueing levels range from the least independent and most concrete, when the teacher assumes most of the leadership in the learning process (Level E), to the most independent and abstract level, when the student assumes most of the responsibility (Level A).

Levels of Teacher Scaffolding

Level E: Teacher modeling. The teacher models the complete performance with verbal explanations. The teacher identifies the elements of the strategy while doing whatever operations are required. The goal is to gain the information is necessary to answer a question about the construct.

Level D: Inviting student performance. Modeling with verbal explanations, accompanied by some student participation. The teacher identifies the elements of the strategy and encourages the student to assist in completion of the task. This generally includes specific questions such as "What word doesn't make sense?" to "Which animal has a tail: an ape or a monkey?"

Level C: Citing specific elements. The teacher identifies the elements of the strategy the student needs to finish the task. "Reread and look at the picture."

Level B: Cueing specific strategies. This uses verbal cueing without reference to the specific elements of the strategy. Only the name of the strategy is used. "What were you looking for in the video?" "Which menu selection would help you find the answer?"

Level A: Providing general cues. This type of verbal cueing will apply to any context and gives the least amount of teacher support. "Does that make sense?" "What can you do to find out?"

APPENDIX O

PROTOCOL FOR TEACHER SCAFFOLDING WITH COMPREHENSION MONITORING

Protocol for Teacher Scaffolding with Comprehension Monitoring for "Sea Mammals"

The primary difference between comprehension monitoring only and teacher scaffolding plus comprehension monitoring is that the monitoring steps are not managed by the student alone. They are part of the scaffolding dialog with the teacher. If an incomplete answer or incorrect, the teacher follows the monitoring steps with the child in an open-ended dialogue according to the Levels as described in the Protocol for Teacher Scaffolding.

Use regular introduction to "Sea Mammals" through first four frames. After student has selected either whales or seals, start with this procedure beginning on either whale or seal construct menu: "You need to keep in mind 4 questions as we look at each of these areas of information. Which area do you want to look at first?"

Still on menu screen:

Step 1: Identification of subject: (Phase 1: The **teacher models** the comprehension monitoring steps for the child during the **first and second constructs.**) On the construct menu, the child is instructed to select a topic and answer "What's the topic?" Example: If child chooses "Where they live" say, the topic is: where they live.

Step 2: Rephrasing in question form: Next, the child is instructed to turn the subject into a question - "What's question I'm trying to answer" becomes "Where do whales live?"

On information screen(s):

Step 3: Selecting the key phrases and rehearsal: After reading and listening to the text, looking at the graphic and/or video, the child next asks "What do I need to remember?" On the first screen, the key points are that whales live in the seas and oceans all over the world. On the second screen, the key point is that some whales also can live in specially built water parks where we can see, touch, pet and feed them.

Step 4: Recall: The response to the question "What's the answer?"
The answer is what whales live in the seas and oceans around the world and also in specially built water parks.

Phase 2: The **teacher and the child use the steps together for the remainder of the constructs.**

At the end of the practice session, note the child's general ability to use steps. The same degree of ease with steps should be reached in review process with "Wise Lifty".

Protocol for Teacher Scaffolding with
Comprehension Monitoring for "Wise Lifty"

Use Level E to review use of comprehension monitoring steps in addition to the general dialogue generated with this screen. Repeat the process until the child displays level of understanding equal to that obtained on "Sea Mammals". Use comprehension monitoring on the following sections:

Alike and Different: What they eat, Noses, Rears and Move

Also use on all problems.

Level E: Teacher modeling. The teacher models the complete performance with verbal explanations. The teacher identifies the elements of the strategy while doing whatever operations are required. The goal is to gain the information is necessary to answer a question about the construct.

Level D: Inviting student performance. Modeling with verbal explanations, accompanied by some student participation. The teacher identifies the elements of the strategy and encourages the student to assist in completion of the task. This generally includes specific questions such as "What word doesn't make sense?" to "Which animal has a tail: an ape or a monkey?"

Level C: Citing specific elements. The teacher identifies the elements of the strategy the student needs to finish the task. "Reread and look at the picture."

Level B: Cueing specific strategies. This uses verbal cueing without reference to the specific elements of the strategy. Only the name of the strategy is used. "What were you looking for in the video?" "Which menu selection would help you find the answer?"

Level A: Providing general cues. This type of verbal cueing will apply to any context and gives the least amount of teacher support. "Does that make sense?" "What can you do to find out?"