Order Number 9406693

The effects of pairing, training, and gender on second graders' content-mastery of a hypermedia science lesson: A factorial experiment

Kwan-Ching, Jane YinLeng, Ph.D.

The University of North Carolina at Greensboro, 1993

U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

THE EFFECTS OF PAIRING, TRAINING, AND GENDER ON SECOND GRADERS' CONTENT-MASTERY OF A HYPERMEDIA SCIENCE LESSON: A FACTORIAL EXPERIMENT

by

Jane YinLeng Kwan-Ching

A Dissertation Proposal Submitted to
the Faculty of the Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of Requirements for the Degree
Doctor of Philosophy

Greensboro

1993

Approved by

J. Allen Watson

Dissertation Advisor

APPROVAL PAGE

This dissertation has been approved by the following committee of the Faculty of the Graduate School at the University of North Carolina at Greensboro.

Dissertation Advisor [signature]

Committee Members [signature]

[signature]

[signature]

July 9, 1993
Date of Acceptance by Committee

July 9, 1993
Date of Final Oral Examination

ACKNOWLEDGEMENTS

I would like to express deep appreciation and gratitude to my dissertation committee chairperson, Dr. J. Allen Watson, for his mentorship and wisdom throughout my research experience. I am also indebted to members of my doctoral committee, Dr. Barbara DeBaryshe, Dr. Hugh Hagaman, and Dr. Hy Rodman for their insights and encouragement during my research study. To my sister, Peck Leng, and my children, Kelton and Benton, I owe the motivation and stamina for completing this study. Finally, I am most thankful for my husband, Albert, whose constant love, encouragement and support made my aspiration a reality.

TABLE OF CONTENTS

LIST OF TABLES

JANE YINLENG KWAN-CHING, Ph.D. The Effects of Pairing, Training, and Gender on Second Graders' Content-Mastery of a Hypermedia Science Lesson: A Factorial Experiment. (1993) Directed by Dr. J. Allen Watson. 163 pp.

The purpose of this study was to examine second graders' performance on a test of content-knowledge based on a hypermedia science program when they were working with a partner of the same sex versus working alone, and when they were given training in systematic self-instruction versus given no training. One hundred and twenty second graders from two public schools in the Guilford County School System were sampled.

Subjects were randomly assigned to one of eight treatment conditions by pairing, training, and gender. The dependent measure was the adjusted posttest scores using the pretest score as the covariate on a test of content-knowledge based on a hypermedia science program about primates. It was hypothesized that female pairs who received training would significantly outperform all other treatment conditions. It was also hypothesized that trained pairs would significantly outperform untrained pairs and individuals. In addition, gender differences were expected between groups of subjects who worked in pairs, while no gender differences were expected between groups of subjects who worked alone.

A one-way ANOVA revealed significant gains for all treatment groups on the content-knowledge posttest scores.

Results from the 2x2x2 ANCOVA showed that untrained subjects who worked alone scored equally as well as trained subjects who worked alone or with a partner on a test of content-knowledge. Untrained subjects who worked in pairs scored significantly lower when compared to all the other groups. There were no significant gender differences found in the study.

It was concluded that individual subjects in this study did not require training to learn content in a hypermedia science program. However, when subjects were paired, training was necessary to help them focus on important and relevant aspects of the subject matter presented on the computer and laserdisc.

CHAPTER I

Background

Computers have changed the way students learn. In the early 80s, computers typically served as electronic workbooks in the classrooms, providing screen after screen of drill and practice exercises. However, questions related to age and developmental-appropriateness were raised regarding the educational benefits of the technology (Barnes & Hill, 1983; Cuffaro, 1984; Elkind, 1987). Currently, there is increasingly less debate about the benefits of using computers for young children. Many researchers and educators have written about and argued successfully that the computer is more than just a novel toy in early education (Kulick, Kulick & Bangert-Downs, 1985; Papert, 1980; Sheingold, 1988; Swick, 1989). Effective and appropriate use of educational computer technology has resulted in positive outcomes such as improvement in problem-solving skills (Clements, 1987; Yates & Moursund, 1989), and increase children's overall motivation toward learning and social behaviors such as turn-taking, and helping others (Lepper & Gutner, 1989). These results have also been observed in very young subjects, i.e., four- and five-year olds (Watson, Nida & Shade, 1986).

Recent breakthroughs in technological hardware and software not only influence the instructional process, but also affect how students learn (Nickerson, 1988). Today's multimedia computers feature touch-sensitive screens, interactive text and graphics, and access to huge memory banks of still- and motion-images, as well as print and graphics. Developed in the last five to ten years, hypermedia takes advantage of technology to change not only the way information is presented, but also the way students think and learn. Hypermedia--the synthesis of various sensory mediums and interactive videodisc technology--has been acclaimed to have great potential for learning in an effective and interactive manner (Lucas, 1992; Nelson & Watson, 1991; Watson, Meshot & Hagaman, 1988). Hypermedia-assisted instruction (HAI) software is distinguished from computer-assisted instruction (CAI) software in its integrated use of multimedia: Video, animation, graphics, sound, text, and its use of link structure (Heller, 1990). Link structure refers to the complex web-like format used to connect information in a software program.

Although the use of hypermedia in education is relatively new, there is documentation of its general effectiveness. Studies using this new technology have shown higher achievement scores, increased satisfaction, and more positive attitudes over learning than with traditional materials (Browning, 1986; Thorkildsen, Allard, & Reid, 1983).

In 1984, there were 350,000 computers in schools across the United States. Today, that number has risen to 3 million (Adams, Carlson, & Hamm, 1990). Despite the availability of equipment and technology, educators are still wrestling with how they can best aid teaching. Research suggests that using technology passively is not effective (Sheingold, Kane, & Endreweit, 1983; Solomon & Clark, 1977). Teachers have to find ways of integrating hypermedia technology into existing curriculum and classroom systems to make learning more interactive and effective. Theories of memory and information processing state that short-term, active memory is limited in capacity. The rule or estimate of 7 ± 2 chunks of information is frequently quoted (Miller, 1957). Therefore, learning that emphasizes rote or passive memorization is limited. Jones (1989) states that perhaps the most important contribution of hypermedia to education may be the ability for learners to interact with information and participate in active cognitive exchange with the technology.

The combination of technology and social influences in the classroom can have a positive impact on learning. Cooperative learning and hypermedia is one such combination. When hypermedia is combined with the skills of collaboration, critical thinking, and group problem-solving, the combination can foster students' self-esteem and academic achievement (Carlson & Falk, 1986). Research in cooperative learning spans over the past fifty years. There is an enormous amount of evidence showing that when students learn cooperatively in small groups of two or more, learning and achievement scores actually improve, along with other social behaviors (Slavin, 1980).

Yet experts caution against thinking that merely putting pairs or a small group of students together would ensure better learning or result in collaborative behaviors (Slavin, 1988). When students are paired to work on a common project or task, there can emerge cooperative or competitive efforts, or domination by one member of the pair (Johnson & Johnson, 1975). Slavin (1980) and Humphreys, Johnson and Johnson (1982) have found that for group learning to work, certain rules and strategies for cooperation and learning have to be taught and enforced. Classroom practice suggests that one good way to structure collaborative learning with technology is for student pairs to make and carry out plans for gathering and exchanging information.

Computer-assisted cooperative instruction has resulted in increased achievement, successful problem-solving, task-related interactions, and enhanced social skills between students (Johnson, Johnson, & Stanne, 1985, 1986; Simek & Tsai, 1992; Webb, 1984). However, research exists which shows that in both computer-assisted and non-computer-assisted cooperative learning, differences in student achievement and gain are nonsignificant (Golton, 1975; Humphreys, et al., 1982; Johnson, Johnson, & Scott, 1978; Slavin, 1988; Yager, Johnson, Johnson, & Snider, 1986). In order for cooperative learning structures to succeed, certain conditions such as degree of cooperation, mutual understanding of learning strategies and task structures, common learning goals, individual accountability, and adherence to cooperative learning rules have to be present (Johnson, et al., 1985; Slavin, 1988).

Over the years, there have been many models for cooperative learning. Among them are Team-assisted Individualization (TAI), Student Teams and Academic Divisions (STAD), Cooperative Integrated Reading and Composition (CIRC), etc. Many of these cooperative learning models have been used successfully with third graders and upwards (Sharan, 1990; Slavin, 1988). It is clear that the benefits of collaboration are reaped only when students are trained to work cooperatively.

Like models of cooperative learning, strategies for recall of information also have been found to improve content-mastery achievement. Self-regulated learning is one such strategy and refers to the process whereby students "engage in planful behaviors oriented toward learning" (Corno & Mandinach, 1983). Mandinach and Corno (1985) found that students who used self-regulated learning were more successful in a computer problem-solving game than those who used other forms of cognitive engagements, such as task focus and recipient learning. Task focus refers to the situation where students invest much effort into specific task situations but who are unable to use information beyond the task itself (e.g., teacher cues and other available resources not directly identified by the task). Recipient learning, on the other hand, has to do with the lack of active information acquisition, and results in minimal mental efforts during the learning process.

Students actively use other learning strategies such as selective perception and planning to attend to the acquisition of academic material. Although this form of learning is ideal, few students can or are expected to practice it consistently. Rather, they are expected to alternate between their own learning and relying some of the time on the instructional environment. Slavin (1980) calls this kind of learning, 'resource management', and states that it is very useful in some academic tasks such as in cooperative learning.

Although much of the literature on gender and computers points to insignificant or no sex differences between individual boys and girls, little has been done with pairs of students learning with computers. In one study, it was found that same-sex pairs seem to do better than mixed-sex pairs on computer LOGO tasks (Underwood, McCaffrey, & Underwood, 1990). Evidence of gender differences is usually found in older students, and from earlier research studies. Male students are often reported to be superior in computer tasks of a spatial and abstract nature (Maier & Casselman, 1970). There is, however, reason to believe that when the computer task is one that is based on language, girl pairs seem to do just as well, if not better (Anderson, Klassen, Kohn & Smith-Cunnien 1979; Underwood & Underwood, 1990).

Theoretical Framework

The theoretical framework underlying the nature of computer-assisted learning studies are embodied in recent cognitive theories such as Piaget's constructivistic learning, information processing, and social learning. According to Piaget (Piaget & Inhelder, 1976), learners are not mere recipients of ideas, but constructors of knowledge. The learner is cognitively responsible for interpreting events, objects, and perspectives in the real world. These interpretations make up a knowledge base that is personal and individualistic. Piagetian theory states that the source of new knowledge comes from the interaction between the learner and the physical environment.

Cognitive theorists approaching learning from the information-processing perspective view knowledge as being organized and stored in structures resembling a spider's web (Atkinson & Schiffrin, 1968). Similar to Piagetian notions, new knowledge is constructed by building on information in one's existing knowledge base. Hypermedia systems allow users to browse through enormous databases that are linked conceptually in a web-like fashion. By encouraging learners to define and create their own learning paths through the knowledge base, hypermedia allows a form of learning which information-processing theorists see as more congruent to the way human memory works (Rumelhart, 1977).

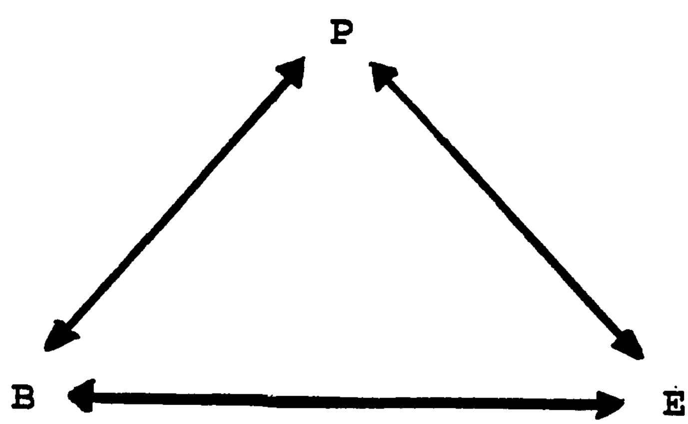
While information-processing theory explains well the nature and processes of thinking, it does not appear to address the social and motivational aspects of learning. Since a major variable of this study involved learning in a social context--learning with a partner--Bandura's social learning theory lends itself very well to the theoretical framework of the study.

Bandura's model of causation (Fig. 1) states that three factors--behavior (B), the external environment (E), and the various internal events (P) which are cognitive and biological that affect perception--are triadically linked and influence each other (Bandura, 1986). While one's perception, goals and intentions shape and direct behaviors, those same thoughts, beliefs and actions are influenced by the social environment that carries information and "activate emotional reactions through modeling and social persuasion" (Bandura, 1989).

Zajonc (1980) states that social learning theory addresses "hot cognition" which includes the emotional and motivational aspects of learning. An example of hot cognition in this study would be a pair of students being motivated to learn when they are aware that the success of completing a computer activity with their partner depends on how well they work together through cooperation and agreement. Motivation is critical to thinking but appears to be unattended to in information-processing theory. Thus, the three theories--Piagetian, information-processing and social learning--together shape the theoretical framework upon which this study is based.

Figure 1.

Bandura's Model of Causation



Statement of the Problem

Science education continues to be a critical subject in all schools. Weiss (1986) and Alridge (1989) reported that today's students take fewer science courses than they did thirty years ago. The majority who do, do not appear to enjoy learning science as a subject (Hueftle, 1983). Hypermedia technology has been used widely to increase science literacy and higher order-thinking skills (Hofmeister, Englemann, & Carnine, 1989; Marchionini, 1988; Zsiray, Goodey, Godfrey, & Larson, 1987).

However, technology by itself does not necessarily ensure better learning. The appropriate use of technology determines its effectiveness on students' learning and achievement. Learning with computers has long been viewed as an individualistic activity. The scenario is commonly one of a single student in front of a computer station, often isolated from other peers. Many educators question if such an arrangement is indeed the most effective means for young children to learn with this technology. Cole and Griffin (1987) stated that the optimum condition may be for students to work in pairs or small groups rather than individually. Their conclusion seems to be congruent with social learning theory in that higher-level thinking, e.g., problem-solving, develops from interaction with other peers and through collaborative efforts.

Studies have shown that learning becomes more effective when students learn in pairs or in small groups (Sharan & Shachar, 1988; Spivak, Platt, & Shure, 1976). However, group effort needs to be structured to ensure that group members are aware of the tasks to be achieved together, and individually (Adams, et al., 1990). Both the learning, as well as cooperative strategies must be made known to the cooperating students in order to ensure successful learning. It has been found that groups may work cooperatively or competitively (Johnson et al., 1975) unless specific steps for cooperative work are taught and reinforced. This study manipulated individual students versus pairs of students by gender, and investigated the effects of providing systematic instruction training versus no training on second graders' content-knowledge posttest scores based on a hypermedia science program about primates. Four research questions were asked:

1. Are there significant gender differences in content-knowledge score outcomes between groups in different treatment conditions?
2. Will pairing and training combined significantly increase 2nd graders' content-knowledge gain scores when compared to all other treatment conditions?

4. Does pairing alone produce significant content-knowledge gain score differences between different groups, except for the combined pairing and training condition?

Hypotheses

Based on the preceding research questions, the following hypotheses for the study were tested in this study:

H1 : There will be a significant three-way gender by training by pairing interaction among groups.

(a) Female same-sex pairs who are trained will significantly outperform all other groups.

(b) Female same-sex pairs who are untrained will score significantly higher than both male and female subjects who work individually and who are untrained.

H2 : There will be a significant two-way gender by pairing interaction among groups.

(a) Female same-sex pairs will score significantly higher than male same-sex pairs regardless of training effect.

(b) There will be no significant gender differences in score outcomes of individual subjects regardless of training effect.

H3 : Pairing and training combined will produce higher content-knowledge adjusted posttest scores in groups than all other treatment conditions.

(a) Paired subjects who are trained will have significantly higher adjusted posttest scores than individual subjects who are not trained.

(b) There will be no significant differences in adjusted posttest score outcomes of paired subjects who are untrained and individual subjects who are untrained.

H4 : Groups who are trained will have significantly higher content-knowledge adjusted posttest scores when pairing effects are controlled.

(a) Trained subjects who work in pairs will have significantly higher adjusted posttest scores than untrained subjects who work in pairs.

(b) Trained subjects who work alone will have significantly higher adjusted posttest scores than untrained subjects who work alone.

H5 : Groups who are paired will have significantly higher content-knowledge adjusted posttest scores when training effects are controlled.

(a) Paired subjects who are trained will have significantly higher adjusted posttest scores than trained individual subjects who are trained.

(b) Paired subjects who are untrained will have significantly higher adjusted posttest scores than individual subjects who are untrained.

Importance of Study

Over the years, teachers have continually tried various teaching approaches, curricular materials, learning strategies as well as classroom arrangements to determine the kinds of conditions that best facilitate learning (Sheingold & Tucker, 1990). Although separately there is much evidence pointing to the success of using technology for learning (Bosco, 1986; Hannafin, 1985), and cooperative learning (Newman & Thompson, 1987; Slavin, 1990a), very little is found in the literature that examines the effects of hypermedia learning on collaborative pairs. Many studies can be cited to support the argument that individual students do learn better when using technology than when using traditional reading materials (Clements, 1986; Clements & Gullo, 1984; Miller & Emihovich, 1986). There is an enormous amount of research that points to the benefits of cooperative work in pairs and small groups of children, particularly from third grade upwards (Johnson, et al., 1975, 1986; Kulick, et al., 1985). However, literature which investigates the combined impact of hypermedia and collaborative learning with an age group younger than third grade is scarce. The significance of this study was based on adding to the current knowledge base, extending past research, and in the fact that interactive video instruction will impact the school population at large.

Slavin (1988) and Yager (1986) have shown that cooperative pairs and small groups do better both in achievement and other social areas than individualistic learning. Johnson and Johnson (1985) have found that female and male same-sex pairs perform equally well on word association tasks when taught to use the same cooperative strategies. However, a separate study revealed that girls tend to do better than boys in language tasks and activities requiring communication (Underwood, et al., 1990a).

Given these findings in the various related areas, it was hypothesized that female same-sex pairs of second graders who have been trained in systematic self-instruction and cooperative efforts will score higher on a computerized test of content knowledge based on a hypermedia science program than any other treatment groups in the study. Female same-sex pairs will perform better than male pairs. Systematic self-instruction has been found to be positively correlated with academic improvement (Berliner & Rosenshine, 1976; Stallings, 1980). Therefore, in addition, pairs and individuals who receive training were hypothesized to score higher than pairs and individuals who do not receive training.

Assumptions

Interactive video used in this study were two hypermedia programs designed for use on the Macintosh computer consisting of two screens of information: one screen of textual information and a second screen of visual information (from a laserdisc). The interactive videos were developed using HyperCard and MacroMind Director authoring software and Mammals 1 and 3 laserdiscs from the Encyclopedia of Animals videodisc series.

It was also assumed that subjects in the study were typical of 2nd-graders found in public schools in the Guilford County School System.

Limitations

A major limitation of this study was the use of intact second grade classrooms in two of the schools within the Guilford County School System. Randomization of subjects to treatment conditions was used to compensate for any existing classroom differences in the study. The results of this study can only be generalizable to similar populations of second graders.

Definition of Terms

Hypermedia. Sometimes known as multimedia, the term refers to the use of computers to bring together multiple media such as sound, text, graphics, color, and video to present information on a computer. With the help of special authoring software, hypermedia also allows the user to access information in a nonlinear sequence.

Interactive Videodisc. A level III laserdisc that allows remote control access to any frame on the disc in a nonlinear sequence when played on a laserdisc player. In this study, the interactive videodiscs, Mammals 1 and 3, were taken from the Encyclopedia of Animals videodisc series produced by the National Geographic Society.

Sea Mammals. This is a repurposed HyperCard-written IVD program which contains two separate lessons, one on whales and another on seals. The program contains seven classification constructs and presents lessons through text, visuals and sound.

Primates. This is a two-part hypermedia program based on information about primates. Part I is a teaching segment containing factual information about the two general families of primates. Part II is an adventure story of a fictional monkey which requires the child to classify and problem-solve using skills of observation, and comparing and contrasting.

Computerized Test of Content-Knowledge. A 25-item multiple choice computer test based on the hypermedia program, Primates. The test was used for pretesting and posttesting subjects.

Cooperative Learning. For this study, pairs of students were taught to work together cooperatively. Cooperative learning is a form of group learning whose structure required all students in the group to work together to obtain a common group goal.

Competitive Learning. Competitive learning takes place where students perceive that they can only obtain their goal if the other students they are working with fail to obtain their goal. This study, however, did not use competitive groups.

Individualistic Learning. A student working alone on the computer.

Same-sex Pairs. A pair of boy subjects or girl subjects

Training. In this study, training consisted of two parts. Part I is the six-step Systematic Self-Instruction strategy taught to pairs or individual subjects in treatment conditions designated "trained". Part II involves the four cooperative rules for all pairs working together.

Systematic Self-Instruction. A six-step procedure with prompting cards which provided students with metacognitive strategies to learn and recall information effectively. The model used here was derived and modified from Adams, Carnine, and Gersten's (1982) work.

Cooperative Efforts Guidelines. A set of four cooperative learning rules adapted from Johnson and Johnson's (1985) model to enforce cooperation between pairs of students during a learning task.

CHAPTER II

Review Of The Literature

Recent innovations in educational technology have impressed educators, parents, and society in general. The positive effects of computer-assisted instruction on achievement and attitudes have been documented for a number of subjects and across a broad age span. However, the potential utility of technology-based instructional systems goes beyond the teaching of specific skills and concepts. Interactive systems that link the flexibility of the microcomputer with the capability of videodisc players are assumed to be able to assist learners to acquire self-regulatory processes for improved learning (Henderson, 1986). Those interested in the education of young children are looking to see an optimum synergy of what we know about student learning, conducive educational environments that stimulate academic achievement, and the optimization of available interactive technologies (Sheingold & Tucker, 1990). The availability of technologies such as computers and interactive videodiscs means that some restructuring of the way students learn information is necessary.

The majority of computer programs designed for the classroom fall into one of two categories: Linear, and drill and practice (Litchfield & Mattson, 1989). The combination of "known" methods of teaching with the new media for presenting information points to recent developments, e.g., hypermedia, and a revival of collaborative learning research. As such, the attention of this review of literature is turned to some of the research that has looked at the effectiveness of the new media, a restructuring of student learning environments, and the promotion of students' effective learning.

Hypermedia Learning

Educators are beginning to realize that certain kinds of information are better and more effectively delivered through a combination of visual and auditory means (Adams, et al., 1990). Interactivity seems to separate hypermedia learning from other computer-based instruction such as those provided by CAI software. Traditional learning from textbooks and CAI-type software (e.g., drill and practice electronic games) follow a linear sequence. On the other hand, hypermedia learning provides a nonlinear approach to seeking information. By freeing the learners' dependence on print-on-paper, hypermedia provides access to enormous amounts of information and allows learners to create their own paths through the information, jumping from one set of details to another through interactive buttons. This approach has been claimed by proponents of hypermedia to more closely resemble "human associative memory and thus can serve as powerful cognitive amplifiers" (Marchionini, 1988). Previous studies have demonstrated that performance was superior for students using nonlinear computer-based learning (Evans, 1985; Stanton, 1989).

However, those same characteristics that make hypermedia so rich in information and attractive in presentation may present certain problems of distraction, disorientation, and teacher management (Marchionini, 1988). Disorientation occurs when learners get lost quickly in the vast amounts of information available to them at the click of a button. Distraction is also likely when the high level of learner control inherent in hypermedia programs results in students losing sight of instructional goals in the midst of a rich learning context that is full of information. Problems associated with teaching becomes apparent when teachers try to use hypermedia to meet instructional goals. Some of these problems include designing lessons with hypermedia, managing students' learning on a hypermedia system, creating student assignments and activities, and evaluating learning. Clearly, the benefits of hypermedia are dependent upon the application of the technology in ways that transmit information most effectively and in the most appropriate learning environments.

Interactive Videodisc (IVD) Technology

IVD technology combines the many powerful instructional features of CAI and videodisc with the interactive capabilities of the computer. IVD technology involves the linking of a videodisc player to a microcomputer. The information on the videodisc is then controlled by the computer. The majority of existing educational technology research studies compare student test scores on the same or similar lesson content when presented by a multimedia/IVD instructional program and teacher lecture. Findings generally favor the multimedia/IVD format.

However, the potential of IVD technology has been readily and widely accepted despite a lack of empirically-derived support. In a survey article summarizing the results of interactive video research in the classroom, Stevens, Zech, and Katkarant (1987) reported that of 19 studies investigating achievement as the dependent variable in interactive video research, only 15% reported negative findings, while the remaining studies reported only small positive differences or no differences. Inconsistent results from interactive video studies on student achievement range from statistically significant results to no statistically significant results. These outcomes may be attributable to the reason that not all students benefit equally from interactive video instruction (Barba & Armstrong, 1992).

Science-related Subject Matter

There appears to be much potential for the integration of hypermedia in science education. Pollack (1989) found that 80% of the videodiscs available contain science-related information. Nelson (1981) suggested that hypermedia applications may be excellent tools for storing and distributing scientific information. The unique presentation of information on hypermedia systems make them potentially meaningful and effective vehicles for promoting scientific inquiry. This new technology appears to be "ideally suited for a variety of scientific applications" because of its "ability to organize and manipulate ...information" (Marsh & Kumar, 1992). In fact, several National Science Foundation (NSF) funded projects are currently in key universities (e.g., Vanderbilt University) to restructure science curricula and the natural science components of teacher preparation programs (Marsh & Kumar, 1992). However, with the exception of studies by Diemer, Frakes, Gandell and Fox, (1989), and Fuller (1984), little empirical research has been conducted into the effectiveness of interactive video in the earth and space science classroom.

Age

Age has been found to be among many variables that influence the accuracy and efficiency of learning from video (Hannafin, 1985). Attentional skills of learners appear to improve and change as a function of learner age. It is assumed that younger children would be more stimulus-bound than older school-aged children who are able to apply already developed cognitive processing strategies. Saloman (1983), however, cautioned that the over-familiarity of older learners with television and video may cause them to become less active in processing IVD since they might perceive learning as being very easy. Consequently, they would exert less effort, in which case we may find that younger children may be more active, engaging themselves in the highly motivating presentational formats of IVD. The significance of this study is predicated on filling a gap in the literature and extending previous research because interactive video instruction could impact a wide segment of the population.

Cooperative Learning

Research on cooperative learning has been conducted for many years. However, only in the last fifteen years has extensive research on the topic emerged (Slavin, 1990b). This alternative instructional approach to public education emphasizes interaction among small groups of students during the learning process. Each member within a group is responsible for a learning task that contributes both to group and individual achievement. The peer-interactive nature of cooperative learning enhances and promotes social skills during academic learning. Not surprisingly, one of the clearest findings is that cooperative learning improves social relations among students (Slavin, 1990b).

Cooperative efforts are seen as a means for improving communication and creating the kind of learning environment in which mutual assistance flourishes. Others (Sarason, 1983; Hertz-Lazarowitz & Shachar, 1990) have found that cooperative activities sharply decreased student boredom and disruptive behavior during teacher lectures. Studies also show that advantaged as well as disadvantaged students significantly benefit from collaborative learning techniques (Sharan & Shachar, 1988). Cooperative discussions have also been proven to increase retention and improve the problem-solving ability of all students.

Cooperative small group learning is to be considered an important supplement to whole class instruction and having individuals work alone. Numerous studies of cooperative learning have shown significant student gains in measurements of academic achievement, measures of social relationships, self-esteem, cultural relationships (Slavin, 1990b; Sharan & Shachar, 1988) and growth in higher-order thinking (Hertz-Lazarowtiz, et al., 1980; Webb, 1982).

Cooperative versus Competitive Groups

Cooperative learning is different from traditional group learning in that the former is based on group learning that fosters positive interdependence among group members, individual accountability, heterogeneous ability among members, and the direct teaching of cooperative behaviors. Traditional group learning has homogenous groups which do not have the above characteristics, and assumes that much of the social and cooperative behaviors will occur naturally in a group of students (Johnson & Johnson, 1984).

Competitive group learning dominates in the regular classroom. Teachers typically structure lessons so that students are constantly working against each other. In competitive learning, peers try to work faster and better than everybody else in order to obtain individual goals. As such, there is "negative interdependence among goal achievements as students perceive that they can obtain their goals only if (others) fail to obtain theirs" (Johnson, et al., 1984). Cooperative learning, on the other hand, requires that students seek those goals that are beneficial to all within their own cooperative groups. Positive interdependence is present as one's goal attainment depends upon the goal attainment of the others within the group (Johnson, et al., 1975).

Johnson and Johnson's (1983) work has found that between the two types of groups, cooperative group learning promoted the use of higher reasoning strategies, greater thinking competencies, more positive attitudes and continued motivation toward learning the subjects. They also found that compared with competitive groups, cooperative learning experiences tended to promote greater cognitive and affective perspective-taking and higher levels of self-esteem. Johnson, et al. (1975) also documented superior cognitive outcomes such as problem-solving, mathematics achievement, and reading comprehension in cooperative learning situations than competitive or individualistic settings. In a study of seven-year-olds, Stendler, Damrin and Haines (1951) found that destructive, boastful, and deprecatory behaviors exceeded friendly conversation, sharing, and helping behaviors when the tasks were structured competitively. The reverse was true when the tasks were structured cooperatively.

However, research indicates that competition may be superior to cooperation when the task is simple drill activity or requires little help from another person. When tasks are more complex, e.g., recalling information, cooperation appears to result in higher achievement than does competition (DeVries, Edwards, & Wells, 1974; Edwards & Devries, 1972; Scott & Cherrington, 1974).

Pairs versus Individuals

The old adage that 'two heads are better than one' is verified by recent research which shows cooperative student groups producing better results than students working alone.

In a study of pairs working on a cooperative computer-based language task, Underwood, et al. (1990a) found that moving the subjects from an individual to paired working condition improved the number of attempts and correct attempts. Maverech, Stern and Levita (1987) found, in their study using computers, that students who worked in pairs tended to score higher than those who experienced computer instruction individually. Azmitia (1988) examined five-year-olds in a study of lego building and found that those who worked with a partner showed more collaboration and were better able to generalize their skills than those who worked alone.

While Golton (1975) found no significant difference in mathematics achievement between students who used CAI alone or in pairs, Johnson, Johnson and Stanne (1985) indicated the superiority of computer-assisted cooperative learning over computer-assisted individual learning. Yager (1985) showed that students in cooperative conditions performed significantly higher on accuracy of daily work and scored higher on retention tests than individual students working alone. More recent studies seem to better capture the positive differences between paired versus individualistic learning.

<u>Same-sex Pairs versus Mixed-sex Pairs</u>

The research studies on interaction between gender and pairs have reached conflicting conclusions. Hughes and

Greenhough (1989) found that pairs of girls perform less well than pairs of boys. However, Underwood, et al. (1990b) stated that the Hugh and Greenhough study was the only one with such a conclusion and attributed it to design flaws. Underwood, et al. (1990a) found pairs working together achieved improved performance over working alone, but not with mixed-sex pairs.

Siann and Macleod (1986) noted that girls were outperformed by boys when working in same-sex pairs. An explanation was that girl-girl pairs may have tended to react emotionally more than other pairings when the Logo turtle crashed into the side wall of the computer screen. Gender differences in favor of boys found in most LOGO programming studies are often attributed to the spatial nature of the tasks. Such evidence appears to point to innate superiority in such tasks for males.

In contrast, Underwood, et al. (1990a) used a language task rather than a spatial task and found that the same-sex pairs of subjects (10-12 year-olds) showed no difference in measures of performance. Single-sexed pairs, both boys and girls, showed improvement. Only when the pairs were mixed was there a decline in performance and or no improvement. Another study measured the time taken to attain goals in a Modified Cooperative Game (Stingle & Cook, 1989) by pairs of boys and pairs of girls at ages 5, 8, and 11. The boy pairs in the 11 year old group showed less cooperative behaviors than the girl pairs did, and took longer to attain cooperative goals.

Learning with Computers

Those responsible for children's educational experiences may need collaboration strategies and procedures for applying technology in the classroom. Researchers using IVD and computers have had some successes. Computer-assisted cooperative instruction has been found to increase achievement, successful problem-solving, task-related interactions, and social skills between students (Johnson, et al., 1985, 1986; Simsek & Tsai, 1992; Webb, 1984).

Research evidence also suggests that technology is not very effective when the learner is viewed as a passive recipient of instruction who does not interact with the instruction presented (Sheingold, Kane, & Endrewiet, 1983; Solomon & Clark, 1977). The more interactive and collaborative video instruction becomes, the greater the learning (Seal-Warner, 1988). The presentation of information, the ways employed to learn content, the interaction of students with their peers, and the interaction of technology and learners are all part of the picture.

A recent study found that learners who worked with a partner in a collaborative manner and used videodisc technology achieved higher scores in both content-knowledge and observation skills tests than learners who worked alone with technology, or those who worked with a partner using traditional reading materials. They also completed instruction in an efficient manner and with a relatively high degree of satisfaction (Carlson & Falk, 1987). Carlson and Falk (1989) also concluded that groups can successfully use interactive videodisc and perform better than those working alone. It appears that cooperative videodisc learning may be more efficient than individualistic use of this technology (Noell & Carnine, 1989).

Of five formats that promote a convergence of cooperative learning and interactive technologies (Adams, et al., 1990), the present study was based on one using an interruptible design to teach facts. Such a model is useful when specific information and knowledge needs to be learned and practiced. The format requires learners to periodically stop, and discuss the rules, and apply them. Satisfactory performance is indicated when each learner demonstrates competence in a final test that holds the individual accountable.

Self-Regulated Learning

A learning strategy may be broadly defined as the mental operations or thinking steps that are used to encode, analyze, and retrieve information. Learning strategies are goal-oriented. There are many types of self-regulated learning strategies.

Comprehension Monitoring

Comprehension monitoring is a form of self-regulated learning that involves keeping track of whether or not one is successful in comprehending, and if not, initiating appropriate corrective measures (Gray, 1987). Cue cards have been used to teach comprehension monitoring (Babbs, 1984; Gray, 1987). Ghatala, Levin, Pressley and Locido (1985) found that second graders who were given training in monitoring their use of strategies to perform an associative learning task were able to decide which strategy was more effective, and subsequently abandoned the ineffective one.

Oral rehearsal and summarization of information takes place as comprehension develops. Orally summarizing materials being learned contributes to the efficacy of cooperative learning. Certain strategies are needed for students to regulate their learning within the group.

One possible model for cooperative learning using comprehension monitoring strategies is the Paired Partners: Think Aloud model, much like the one this study used. A partner monitors the student's progress with cues and questions (Whimbey, 1975).

However, not all students possess the social and thinking competencies to be successful in each cooperative learning activity. The evidence does show that children seem to learn best when they are cognitively, emotionally, and behaviorally prepared for a new learning method. There are numerous ways in which children differ in terms of their participation in learning experiences. One of these differences is the extent to which they engage in "the intentional self-regulated learning that promotes literacy" (Palincsar, David, Winn, & Stevens, 1991).

Verbal Self-Regulation

Another form of self-regulatory learning strategy is verbalization. Overt verbalization is a key process that can help develop self-regulated learning among children. Schunk (1986) defines verbalization as overt private speech which does not have a socially communicative function, but is directed toward the self. Overt private speech used in self-regulated learning can include information to be remembered, rules, strategies, etc. Very young children produce verbalizations that do not mediate performance. Subsequently, children develop the ability for verbalization to improve performance but may not produce the relevant verbalizations at the appropriate times (Fuson, 1979). Verbal self-regulatory strategies (e.g., oral rehearsal) need to be taught before children learn to produce task-relevant verbalizations that might benefit performance.

However, Keeney, Cannizo, and Flavell, (1967) and Hsarnow and Meichenbaum (1979) found that the children quickly abandoned verbal rehearsal when no longer required to practice it. It is hypothesized that this discontinued use of the strategy may be because children do not fully understand that such a strategy benefits their performance or that they do not see verbal self-regulation as important for success (Schunk, 1986).

Researchers (Baker & Brown, 1984; Paris, Lipson, & Wixson, 1983) suggest that to maintain verbal self-regulation following training, children should be provided with information linking task-relevant verbalizations to improve performance. They also need training on when and where to verbally self-regulate their performances. The training model used in this study incorporates the above suggestions for training children in verbal self-regulated learning.

Research evidence on verbalization of information to be remembered showed that older children demonstrated better recall (Flavell, et al., 1986; Keeney, et al., 1973). Vocalization also promoted discriminatory learning (Levin, Ghatala, Wilder, & Inzer, 1973; Levin, Ghatala, DeRose, Wilder, & Norton, 1975).

Gender Differences

Research has demonstrated that gender does indeed have an effect on group interaction. In studies examining gender differences in interaction style, it was found that women generally show a greater amount of agreement and other positive behaviors, e.g., showing group solidarity whereas men engage in greater disagreements (Carli, 1989). It has been suggested that women engage in high amounts of positive behaviors. Such behaviors communicate to others that they are simply trying to help the group achieve its goals (Ridgeway, 1978).

Sex-related differences in school achievement and motivation favoring males are also found (Steinkamp & Maehr, 1987). Girls excel at verbal tasks while boys are better at spatial and abstract tasks (Maier, et al., 1970).

Computer-Related Studies

Males traditionally dominate areas such as technology and computers (Swadner & Hannafin, 1987). Boys also had more exposure to computers at home and at school, and had more positive attitudes towards the role of computers in the workplace. In a survey of gender differences in computer studies, Nelson & Watson (1991) cited higher academic performance outcomes in computer activities by males as a result of inequitable time involvement in favor of males. It was also noted that this gender discrepancy could be due to parents socializing boys and not girls towards computers. Gender bias in software was also a possible reason for the sex difference in educational outcomes for males versus females. On the whole, gender differences were found by third or fourth grade, although no difference was found in preschool and early elementary school (Nelson, et al., 1991).

A survey of several hundred UK schools found that girls had little interest in computers. Computer rooms were seen as male territories. However, in a sub-sample containing single-sex girl schools, the girls were enthusiastic about computing as indicated by high levels of participation in computing options and in computer clubs (Culley, 1988).

One of the most thorough survey studies of computer literacy among adolescents conducted by the Minnesota Educational Computing Consortium (MECC) found little evidence of sex differences in computer literacy among a sample of 8th and 11th grade students. Girls and boys were roughly equal in overall computer literacy as well as programming test scores (Anderson, et al., 1979). However, girls outscored boys in items presented as word problems.

Collaborative Studies

Mixed gender groups are reported to be preferred by teachers over single-sex groups (Underwood, et al., 1990b). However, in computer-based tasks which require cooperative work, girls tend to be dominated by boys , even though girls have no disadvantages in these tasks when tested individually or in same-sex groups. Results in the Underwood, et al. (1990a) study show that both types of same-sex pairs improved in performance in comparison to individuals working alone. Single gender pairs tend to share components of the task and discuss possible solutions. Mixed gender pairs tended to separate task components and not engage in as much discussion.

In looking at non-computer gender and cooperative learning literature, some studies have found that females behave more cooperatively than males (Ahlgren & Johnson, 1979; Miller & Pike, 1973), and had persistently higher cooperative attitude means than boys. Developmental psychologists have shown that boys are rewarded more for competitive behaviors than are girls (Barry, Bacon, & Child, 1957). In spite of these findings, some researchers suggest that perhaps there is a sex stereotype that males are more competitive and less cooperative than females (Broverman, Broverman, Clarkson, Rosenkrantz, & Vogel, 1970). There have been other studies that report no differences between males and females in cooperative behaviors (e.g., Crockenberg, Byrant, & Wilce, 1976). Females have been found to be more competitive and less cooperative than males, especially when matched with other females (e.g., Carment, 1974).

CHAPTER III

Methods and Procedures

Subjects

One hundred and twenty second grade students, 60 boys and 60 girls, were used in this study. The subjects came from two comparable schools within the Guilford County School System. Forty-six (38%) of the subjects came from Rankin Elementary School, while the other 74(62%) came from Madison Elementary School. Both schools are located in the Northeastern part of Guilford County in North Carolina, serve approximately 550-600 students, and provide academic programs from kindergarten through fifth grade.

All subjects came from intact second-grade classrooms picked by the respective school principals for inclusion in the study. Letters of permission were sent home with the students about a week prior to the start of the study (see Appendix A). Parents who gave consent were assured of the confidentiality of student demographic information gathered from the schools and during the course of the study. A high parental response rate was received. Of the 135 forms sent home, 130 (94.2%) were returned. Of these, only two indicated non participation. Overall, the study obtained a 98.5% positive response rate. Eight of the 128 subjects initially included in the study were dropped for reasons such as absenteeism, unwillingness to complete treatment, or improper training procedures in the course of the study. One female student was randomly dropped upon completion of the study in order to obtain equal number of subjects in each of the treatment cells. Of the final pool of subjects used, 12% were Black while the rest were White. The mean age of the subjects was 7.8 years.

Classroom teachers were provided with a daily schedule indicating the number of girls and boys needed at a specific time slot everyday during the study (see Appendix B). Each teacher then filled in the names of boys and girls who were available during those times. None of the teachers were aware of what each child did each day during the four days he or she was pulled out from the classroom. Subjects were randomly assigned to one of eight treatment conditions as shown in Table 1. Twenty pairs of boys were equally and randomly assigned to treatment conditions T2 and T4, and 20 pairs of girls to treatment conditions T1 and T3. At the same time, 20 individual boys were randomly assigned to treatment conditions T6 and T8, and 20 girls to treatment conditions T5 and T7.

Subjects were pretested at the beginning of each week, given a two-day treatment, and were posttested on the fourth day. In all, each subject received two 20-minute tests, two exposures (a 20-minute and a 45-minute) to hypermedia

Table 1

Number of Subjects in Treatment Group With and Without Training by Gender and Pairing

	Pairing	
Gender	Pairs	Individuals
Girls		
With	10	10
Without	10	10
Boys		
With	10	10
Without	10	10

Note. Total number of subjects = 120.

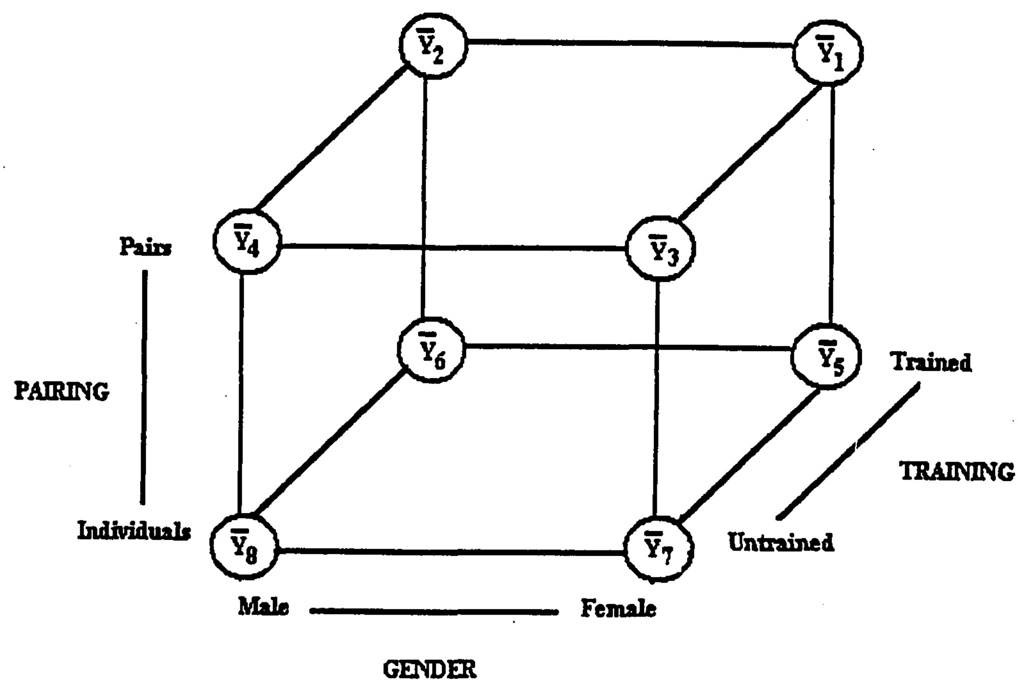
computer experience over four days within the same week. Each of the paired subjects in treatment conditions T1 through T4 took the pretest and posttest individually. However, each pair had their scores averaged to arrive at one common score. As a result, only 80 observations per pretest and posttest were used in the analysis.

Design

This was an experimental research study using an ANCOVA model for a three-factor design with two fixed levels (see Figure 2). Each of the three factors--pairing, training, and gender--had two levels. A factorial design was chosen here as it allowed an examination of the existence of interactions among factors, and tested for the significance of the interaction. It also accounted for more systematic variations, thereby increasing statistical control and reducing random error. Multiple factorial designs have been kn*own to use data more efficiently than single factor ones since they permit the examination of several statistical hypotheses. Subjects were classified according to pairing--working in pairs versus working alone, training--receiving training or no training, and gender--males versus females. There were no mixed-sex pairs used in this study.

Figure 2

A Schematic Representation of the 2X2X2 ANCOVA MODEL



Adapted from Neter, Wasserman, & Kutner (1985).

Treatment consisted of all subjects being exposed to two hypermedia computer lessons using laserdiscs over two days. The first day of the treatment involved a 20-minute lesson on whales using a black-and white monitor connected to a laserdisc player, while the second day included a 45-minute hypermedia lesson on primates using a different laserdisc and a color computer monitor. Subjects who were assigned to trained conditions received training on systematic self-instruction (see Figure 3). Subjects assigned to paired conditions received guidelines for working cooperatively (see Figure 4).

Subjects were pretested and posttested on the computer. However, the scores of paired subjects were averaged to provide a common score for each pair. After consulting with three statistical experts, two suggested averaging pair scores over randomly picking one score from a pair of subjects. This procedure was chosen since averaged scores between pairs appears to be a more stable indication of a paired score. Posttest scores were used for the data analysis using pretest scores as the covariate to show any mean differences between groups. Multiple pre-planned t-test comparisons were made between pairs of treatment groups. The Bonferroni experimentwise error rate of alpha =.01 was adopted.

Figure 3

SYSTEMATIC SELF-INSTRUCTION MODEL

STEP **1** * Look at topic chart* beside the computer.

STEP **2** * Memorize topics.
* Look away and recite.
* Look back if needed.

STEP **3** * Read and memorize each question on chart.

STEP **4** * Find the answer to questions in Step 3.

STEP **5** * Look at questions on topic chart again.
* Recall facts for each question.

STEP **6** * Without looking at the computer, verbally recall information in Step 5 .

Well Done!

Figure 4

COOPERATIVE EFFORTS GUIDELINES

1. Take turns with your partner.

2. Agree with partner before clicking on the computer.

3. Check your partner's learning.

4. At end of session, discuss how well you worked together.
   How can you do better next time?

Two Heads Are Better Than One!

Independent Variables

There were three main variables in this study--pairing, training, and gender. Subjects were randomly assigned to either a paired or individual condition. There were 80 subjects (40 males, 40 females), or 40 same-sexed pairs in the paired condition. Forty individual subjects (20 males, 20 females) made up the subjects in the individual condition. Half of all the same-sexed pairs and individuals (30 males and 30 females) received training while the others did not receive any training.

Dependent Variable

The dependent variable of interest was the adjusted posttest score from the content-knowledge test for each group. Adjusted posttest scores were determined by conducting an ANCOVA on posttest scores using pretest scores as the covariate.

Testing

Content-Mastery Test

A 25-item test based on concepts and facts covered in the Wise Lifty's Primates (from here on referred to as Primates) hypermedia science program was used to measure subjects' content-knowledge. The test was pilot-tested using forty second-graders not included in the study sample in order to test for usability, to iron out any program bugs, and to ensure that it would be appropriate for the grade level intended.

Pilot Study for Content-Mastery Test. Pilot test subjects were recruited from two intact classes from Millis Road Elementary School within the Guilford County School System. One of the classrooms served as the test-experimental group which was shown the Primates program individually and in pairs. The second served as the control group which did not receive any treatment. Nineteen subjects from each classroom were used in the analysis to determine the 25 test items that would be used in the final content-knowledge test for the actual study.

A posttest of 79 items was administered to each of the two classes as a group using overhead projection. Subjects responded by marking on computer answer sheets which were analyzed by computer. An item analysis was then performed on each of the 79 test items by group. Items which were correctly answered by more than 75% of the control group were discarded. Items which were answered correctly by more than 75% of the experimental group but less than 25% of the control were adopted.

The item difficulty index on the 25 items was used to place the questions in the final content-knowledge test. Questions were arranged so that the easier questions were at the beginning and end of the test. Questions dealing with the same concepts were not placed immediately following each other.

The final 25-item multiple-choice format test was delivered by computer to individual subjects in the actual study. Each subject was assigned a unique subject code used throughout the study. Correct responses were assigned a value of 1, and incorrect responses had a value of 0. The subjects' responses were inputted by clicking on one of three choices on the computer screen using a mouse. Each of the 25 items on the content-knowledge test was presented on one screen, one at a time. The entire test was voice-recorded. Special buttons allowed subjects to click on the screen with the mouse to hear any printed word over again at any time. A list of the 25 test items is included in Appendix C.

Equipment

The equipment used in this study consisted of four Macintosh Apple computers--2 SEs, 1 Centris 610, and 1 Mac IIci, four laserdiscplayers--Pioneer 2200 and 4200 Level III interactive laserdiscplayers, two black-and-white monitors, two color monitors, four television monitors, and four copies of National Geographic Society's Encyclopedia of Animals videodisc series--Mammals 1 and Mammals 3 laserdiscs. Two multimedia authoring software--Hypercard by Claris, Inc. and MacroMind Director produced by MacroMedia, Inc.-- were used to develop the hypermedia programs used during the 2-day treatment. Six headsets were also used during the study. The equipment was set up in four separate hypermedia workstations consisting of a computer, a TV monitor and a laserdiscplayer. Each hypermedia workstation was arranged so that subjects would not be able to see the screens of the other workstations (see Appendix D).

Experimenters

The researcher served as the trainer cum experimenter. Three other adults who had experience working with young children and computers were trained to administer the treatment. The researcher who was responsible for training all 120 subjects on the guidelines for cooperative work, as well as the systematic self-instruction strategy used a training protocol for each day of the treatment (see Appendix E). The other three experimenters were trained to provide verbal prompts to trained subjects to refer to the cue cards used to implement the systematic instruction model. Each of the three experimenters who were unaware of the purpose of the study worked with all eight groups of subjects. They were trained to follow strictly the protocols provided in order to reduce the amount of variation in the quality of experimenter interaction with the subjects (see Appendix F). Experimenters were trained to provide verbal encouragement as needed to all subjects.

Procedure

Data Collection

Data collection was conducted on an individual basis Monday through Friday at the two Guilford County System schools between 7:45 a.m. and 2:00 p.m. for four weeks. At the first school, data collection and treatment were conducted in a separate trailer designated as the Chapter I Parent Resource Center. At the second school, data collection and treatment were conducted on the school stage when there were no events taking place on stage. Four children were tested simultaneously at any one time. The computers were arranged so that the subjects would not be able to see the other computer screens during the test. In addition, headsets were used to eliminate any noise distraction. The same 25-item test was used as the pretest and posttest. Data was automatically collected on the computer.

Orientation

All subjects were given a brief orientation on the proper use of equipment before pretesting and prior to treatment.

Treatment

Treatment consisted of two parts--training and computer exposure to two hypermedia software programs.

Part I-Training. Training was divided into two types--systematic self-instruction training, and cooperative effort guidelines. Paired subjects assigned to trained treatment conditions received both parts of the training while individual subjects who were assigned to trained treatment conditions received only training in systematic self-instruction. At the same time, paired subjects not assigned to trained conditions received guidelines on how to work cooperatively.

Systematic Self-Instruction Training. The systematic self-instruction model used in this study was a six-step procedure derived from Adams, et al. (1982). This learning approach was an outgrowth of Robinson's (1941) SQ3R study method used widely with upper elementary-aged students and above. In other studies, systematic self-instruction has been found to be positively correlated with academic improvement (Berliner & Rosenshine, 1976; Stallings, 1980) and includes metacognitive elements from Brown and Smiley's (1978) work on the development of metacognitive strategies for studying text.

Since the present study used computers and subjects in second grade rather than textbooks and upper elementary level students as is the case when the above mentioned study method was commonly used, the model was modified. The steps within the model had been carefully reworded to reflect the presentation of information through a hypermedia computer program as well as simplified to be age-appropriate for second grade subjects. However, the integrity for each of the six steps from the Adams, et al. (1982) model had been retained with each step reflecting the same rationale. For example, in Steps 2 and 5, subjects are told to memorize information, look away and verbally recite the information. This strategy involved the use of conscious verbal self-regulation which Fuson (1979) identified as being beneficial to learning situations that required simple recall than more complex cognitive tasks.

Schunk (1986) also noted that the use of overt private speech, a form of verbal self-regulation, tended to improve task performance. In Step 6, subjects were expected to verbally recall inforamtion wihtout looking for clues on the computer. This strategy served to reinforce the facts learned, and to help subjects focus on recall of task-relevant information outlined on the topic chart they were provided with. Although apparently redundant, Step 6 was meant to serve as a final rehearsal of the pertinent facts covered in the hypermedia program.

Training for the systematic instruction model took place over two days with either individual subjects or a pair of subjects at a time. The subjects were given a prompting card to help them execute each step (see Appendix

G). After the training, the trainer/observer reminded subjects to refer to the prompting card to help them work through each topic in the hypermedia computer program.

All subjects receiving systematic self-instruction training spent approximately a 20-minute session on the Systematic Self-Instruction Model outlined in Figure 3. Sea Mammals, a black and white hypermedia program created using Hypercard software was used as content matter for practicing the six steps in the training model. These subjects then used the Primates prompting card to apply the same model while working on the Primates hypermedia program in a separate 45-minute period session the next day (see Appendix H).

Cooperative Efforts Guidelines. All paired subjects received guidelines on how to work cooperatively as outlined in Figure 4. As part of the cooperative efforts guidelines, subjects were told that all decisions and responses had to be agreed upon between the pair working together prior to having responses entered into the computer. Subjects were also encouraged to take turns.

Part II-Hypermedia Computer Experience. All subjects were exposed to two hypermedia science programs over two days. The two programs--Sea Mammals and Primates--were developed by the University of North Carolina at Greensboro Children and Technology Team. Both programs were developed from information found in textbooks, video footage and still shots from the Encyclopedia of Animals videodisc series, Mammals 1 and Mammals 3.

Sea Mammals. Sea Mammals is a repurposed Hypercard-created IVD program for K-2 grade students. The program presents seven classification constructs about whales and seals but was modified for this study. Only three constructs about whales were shown to the subjects. The three constructs included: The largest member of the whale family, how whales breathe, and how whales move. In Sea Mammals, "age-appropriate, project-authored text and hypermedia technology, e.g., videodisc, still, slow motion and normal speed moving pictures, digital and analog sound, free-hand and scanned graphics, and animation were built into the design of the software...(and activated by) a button which is a graphic of a (TV) monitor, a construct segment coupled with a video segment on a color TV monitor placed next to the computer" (Watson, Nelson, Meshot, Hagaman, & Busch, 1989).

The software program used a videodisc--Mammals 1--from the Encyclopedia of Animals series. All text on the screen was read by one of the experimenters working with an individual or a pair of subjects with the subjects controlling the pace of the lesson by using the computer mouse. In all, subjects in each group spent approximately 20 minutes on the Sea Mammals program.

Primates. Primates is a hypermedia software program design for use with 2nd-graders. The program was developed by the Children and Technology team directed by Dr. J. Allen Watson at the University of North Carolina at Greensboro. The Primates program contained two major parts: Part I was a teaching segment containing factual information about two kinds of primates, namely apes and monkeys. Part II was an adventure story about a fictional character, Wise Lifty--a monkey-like creature who requested the help of the child(ren) at the computer to identify unknown primates by reading clues and looking at video clips.

Several pedagogical issues were considered during the design of the Primates program. First, scientific process skills were chosen as the major focus of the program since it is a critical area in science education. The two basic process skills incorporated in the program were classifying and problem-solving using skills of observing, and comparing and contrasting, and are identified in Bloom's taxonomy of educational objectives (Bloom, 1956). Second, various media elements such as audio, visual, animation, etc. were carefully and deliberately chosen to create a motivating yet effective piece of software program which would engage children in learning. What follows is a detailed description of both the storyline as well as the design elements of Primates.

The story of Primates unfolds with the main character, Wise Lifty, an animated monkey-like creature who acknowledges the presence of the children at the computer by saying:

> "Hi! I am Wise Lifty and I live in the jungle.
> I need your help little friend."

When Wise Lifty makes the association of the children at the computer as its friends, it immediately draws them into an emotional relationship with the character. The children are told that Wise Lifty has a problem and that their help is needed to resolve the problem. By appealing to the children's sense of compassion to help identify and send a group of new primates to join their friends in the jungle, the result is motivated children at the computer who are eager to help a very busy Wise Lifty overcome a conflict. Strickland and Morrow (1989) confirmed that it is very important to set a purpose for listening to or reading a story.

Following the introduction, and the setting of a purpose for the story, the children are then told that in order to help Wise Lifty identify the unknown primates, they need some information. The next part of the program follows with the presentation of information about the scientific process skills of classification and problem-solving using observing, and comparing and contrasting, and the two kinds of primates, apes and monkeys. Information about where primates live, the different examples of apes and monkeys, and the ways that apes and monkeys are alike and different are presented through a combination of motion video images, still clips, graphics, animation, jungle sounds, and narration.

The first part of the program containing information about primates presents concepts in submenus from which the children may choose what they wish to see first. For example, one of the concepts is about classifying apes and monkeys by how they are alike and different. A menu appears showing two choices: Alike and Different (see Appendix J). The child chooses one of the buttons by clicking on the screen with a computer mouse. If the 'Alike' button is clicked, the program branches into the segment that discusses the three ways that apes and monkeys are alike in, i.e., what they eat, how their hands look and work, and how their arms look and work (see Appendix K). In this segment, the child is required to choose one of three concepts to view first, e.g., the child may choose the concept dealing with how their (apes' and monkeys') arms look and work. When the appropriate button is clicked, the child is presented with a screen of text information about ape and monkey arms. A pre-recorded human voice reads the text to the child while the child clicks on another button with a TV monitor icon to view the related video segment about apes' and monkeys' arms.

By providing children submenus to choose from, the decision as well as control for learning is placed in their hands. Piagetian theory suggests that learning should be self-directed since children often make sense of learning on their own. However, although the children do choose the order of information they wish to explore, the program is designed such that they have to look at all the information on each section at least once before going on to another section. This imposition is necessary to ensure that all children view the information at least one time through. Hannafin (1985) found that younger learners needed greater control imposed upon their learning, and in this program, control is built-in by incorporating checks into each submenu. For example, the child choosing to look at differences between an ape and a monkey is provided with a menu of the three ways the two primates are different. If the child chooses the button about the primates' noses, e.g., "noses--how they look", the screen provides a choice between looking at an ape's nose or a monkey's nose (see Appendix M). When the child clicks on the graphic of an ape first, information about apes' noses will be presented through text, graphics and video. When the child finishes viewing the information, he/she is returned to the same menu screen with the ape and monkey graphics, only this time the ape graphic has a check above it (see Appendix M again). Where children do not see a check above or beside a button option, it is a clue to tell them that they have not seen that particular piece of information yet. The children are required to view all pieces of information before moving on to another concept to ensure that each subject has an opportunity to view the same pieces of information about the topic prior to the posttest. At the end of the first part of the program, a brief summary of the classification process and concepts is presented to the children as a from of review (see Appendix N).

The second part of Primates allows children to use their skills of observation, and comparing and contrasting to solve problems. The segment is presented as an adventure story to the children who are requested by Wise Lifty to help solve four problems embedded in two locations within the jungle: Among the trees and behind rocks (see Appendix I). The four problems present a situation for self-motivated investigation as the children await one of four problems to appear from the mysterious locations. Each problem focuses on a specific concept and requires the children to use information on apes and monkeys learned from the first part of the program, e.g., problem four expects the children to observe three different video clips of primates eating, and then answer the question: "Which primate is eating leaves?" (see Appendix O). Children also are given verbal and visual feedback to their responses, e.g., when children click on the wrong answer to problem four, an animated Wise Lifty shakes its head from side to side and says, "Sorry! The chimpanzee is eating leaves." At this point, the child's only option is to click on the TV icon to go back to the video segment to verify instantly what the chimpanzee was eating (see Appendix P). When a correct choice is made, the child is rewarded both visually and verbally, e.g., an animated Wise Lifty's head nodding says, "Good job! The Red Uakari is the primate eating leaves!" (see appendix Q), and is able to go on to solve the next problem.

Several media elements were purposefully incorporated in to the design of Primates. First, young children become highly motivated when they are able to see something happen at a click of a button, e.g., when the word-button "world" is clicked, a map of the world appears showing places where primates live being highlighted in red. Additionally, the use of buttons fosters self-directed learning since children are allowed to determine which pieces of information they wish to view first. Second, buttons allow children to navigate through the information base contained in the program; a design which is unique to hypermedia programs. Most hypermedia programs are omni-directional, that is it allows the program to branch in many directions without overwhelming the child with too much information at one time.

The use of carefully selected video clips added to the richness of the information provided in Primates, and invited children to explore further. The video segments were carefully edited and kept reasonably short so that only relevant information would be included in each clip. Human-voice recorded narration was used with the video segments in order to direct the children's attention to the important information on the video footage, e.g., when viewing a video clip on a chimpanzee, the narration might say, "This is a chimpanzee. It's nose is flat." Predetermined time delays on still video shots were built in to allow the children enough time to study the visual.

Wherever appropriate, graphics were used to foster word-picture association, and color and animation were used generously throughout the program. An animated world map, and various animal graphics provided visual stimuli in addition to the video clips used. However, the design rules of clarity and appropriateness were not sacrificed while trying to make the program appealing and exciting to young children as possible.

In order to control for differences in reading abilities, the entire program was voiced recorded. A special button allowed children to click and listen to the text as many times as they desired. All text were carefully worded to reflect age-appropriate and scientifically correct language. The type and size of font chosen was deliberate to ensure easy reading on the computer screen for 2nd-graders. The total amount of text per screen was limited to three to four sentences so that children would not be overwhelmed by the text.

The design and development of the Primates program took over two years from start to finish. Several doctoral graduate students directed by Dr. J. Allen Watson at the University of North Carolina at Greensboro were involved in the initial development process. The final program used in this study also had the invaluable input of professionals in the use of technology with young children, and met the approval of the Guilford County Curriculum Development and Instruction Center, and the Research Review Team.

CHAPTER IV

Results

The overall range, mean and standard deviations for the pretest, posttest, and raw gain scores are shown on Table 2. The design selected for this study was an experimental factorial model with 10 hypotheses all tested with a 2 (training versus no training) by 2 (pairs versus individuals) by 2 (female versus male) analysis of covariance on adjusted posttest scores using pretest scores as the covariate. One hundred and twenty subjects were randomly assigned to eight different treatment groups.

A one-way analysis of variance (ANOVA) was conducted on the pretest score mean scores. This analysis is critical especially when the pretest scores comprise the covariate because when the adjustment has been made for pretreatment scores, any difference in the adjusted posttest scores can then be more clearly attributable to treatment effects. The ANOVA on pretest scores found homogeneity among the eight groups (see Table 3). Pretest group means and their standard deviations for each of the eight treatment conditions are presented in Table 4. Trained male pairs had the highest pretest mean of 13.1 (SD=3.3) while untrained male individuals subjects had the lowest pretest average of 9.8 (SD=2.4).

Table 2

Range, Means and Standard Deviations for Overall Pretest, Posttest and Raw Gain Scores

Scores	n	Range	Mean	SD
Pretest	80	4 - 7	10.78	2.75
Posttest	80	8 - 23	15.53	3.40
Raw Gain	80	-2 - 18	4.65	4.13

Note. Maximum score = 25.

Table 3

Analysis of Variance on Total Pretest Scores

Source	df	SS	MS	F	p
Training	1	11.25	11.25	1.42	.2368
Gender	1	0.11	0.11	0.01	.9054
Pairing	1	4.05	4.05	0.51	.4764
Traini*Gender	1	1.51	1.51	0.19	.6631
Traini*Pairi	1	2.45	2.45	0.31	.5794
Gender*Pairi	1	5.51	5.51	0.70	.4064
Gender*Pair*Train	1	4.51	4.51	0.57	.4523
Error	72	569.05	7.90		
Total	79	598.45			

Table 4

Pretest Score Means and Standard Deviations by Treatment Group

Group	Pretest	
	Mean	SD
Trained Females		
Pairs	10.4	4.7
Individuals	11.5	3.7
Untrained Females		
Pairs	10.7	2.8
Individuals	10.2	3.4
Trained Males		
Pairs	13.1	3.3
Individuals	10.7	2.5
Untrained Males		
Pairs	10.7	2.7
Individuals	9.8	2.4

Note. Maximum Score = 25.

Due to the design selected in which interactive videodisc treatment was presented, and due to the expectation that treatment would produce significant learning, research hypotheses suggest a pretest-posttest difference. The appropriate thing to do when working with several groups separated by independent means is to test for differences among the groups. After the statistical equivalence of groups was established, the next step in the analysis was to perform an analysis of covariance (ANCOVA) on the posttest scores using pretest scores as the covariate. The mean posttest scores and their standard deviations for each of the eight treatment groups are shown on Table 5. After the posttest, trained male pairs remained the group with the highest mean score of 17.8 (SD=3.3), while untrained male pairs had the lowest posttest mean score of 11.6 (SD=3.0).

The raw gain scores and standard deviations for each treatment group are shown on Table 6. After adjusting for any pretest influence on the posttest scores using pretest scores as the covariate, a visual examination of the adjusted posttest score means revealed that trained male pairs obtained the highest adjusted mean score gain of 4.7 (adjusted posttest mean= 17.8, SD=3.0), while untrained male pairs made the least gain of 2.2 (adjusted posttest mean=

Table 5

Posttest Score Means and Standard Deviations by Treatment Group

	Posttest	
Group	Mean	SD
Trained Females		
Pairs	14.2	3.7
Individuals	15.7	3.0
Untrained Females		
Pairs	11.9	4.6
Individuals	16.1	4.4
Trained Males		
Pairs	17.8	3.3
Individuals	16.7	3.0
Untrained Males		
Pairs	11.6	3.0
Individuals	16.1	2.6

Note. Maximum Score = 25.

Table 6

Raw Gain Score Means and Standard Deviations by Treatment Group

	Raw Gain	
Group	Mean	SD
Trained Females		
Pairs	3.8	3.6
Individuals	4.2	4.3
Untrained Females		
Pairs	1.2	5.6
Individuals	5.9	6.7
Trained Males		
Pairs	4.7	4.5
Individuals	6.0	3.8
Untrained Males		
Pairs	0.9	4.3
Individuals	6.3	3.5

Note. Maximum Score = 25.

Table 7

Adjusted Posttest Score Means and Standard Deviations by Treatment Group

	Adjusted Posttest		
Group	Mean	SD	p
Trained Females			
Pairs	15.0	3.0	.0001
Individuals	15.6	3.0	.0001
Untrained Females			
Pairs	13.2	3.0	.0001
Individuals	16.2	3.0	.0001
Trained Males			
Pairs	17.6	3.0	.0001
Individuals	16.7	3.0	.0001
Untrained Males			
Pairs	12.9	3.0	.0001
Individuals	16.2	3.0	.0001

Note. Maximum Score = 25.

12.9, SD=3.0) (see Table 7). However, an overall analysis of covariance determined that the gain made by each of the eight treatment groups were found at the .0001 level.

The four specific research questions and their respective hypotheses tested in the analysis are listed below:

1. Are there significant gender differences in content-knowledge score outcomes between groups in different treatment conditions?

H1 : There will be a significant three-way gender by pairing by training interaction among groups.

(a) Female same-sex pairs who are trained will significantly outperform all other groups.

(b) Female same-sex pairs who are untrained will score significantly higher than both male and female subjects who work individually and who are untrained.

H2 : There will be a significant two-way gender by pairing interaction among groups.

(a) Female same-sex pairs will score significantly higher than male same-sex pairs regardless of training effect.

(b) There will be no significant gender differences in score outcomes of individual subjects regardless of training effect.

2. Will pairing and training combined significantly increase 2nd graders' content-knowledge adjusted posttest scores when compared to all the other treatment conditions?

H3 : Pairing and training combined will produce higher content-knowledge posttest scores in groups than all other treatment conditions.

   (a) Paired subjects who are trained will have significantly higher aadjusted posttest scores than individual subjects who are not trained.

   (b) There will be no significant differences in adjusted posttest score outcomes of paired subjects who are untrained and individual subjects who are trained.

3. Does training alone produce significant content-knowledge posttest score differences between different groups, except for the combined pairing and training condition?

H4 : Groups who are trained will score significantly higher on a content-knowledge adjusted posttest when pairing effects are controlled.

   (a) Trained subjects who work in pairs will score significantly higher on the adjusted posttest than untrained subjects who work in pairs.

(b) Trained subjects who work alone will score significantly higher on the adjusted posttest than untrained subjects who work alone.

4. Does pairing alone produce significant content-knowledge adjusted posttest score differences between different groups, except for the combined pairing and training condition?

H5 : Groups who are paired will score significantly higher on a content-knowledge posttest when training effects are controlled.

(a) Paired subjects who are trained will have significantly higher adjusted posttest scores than individual subjects who are trained.

(b) Paired subjects who are untrained will have significantly higher posttest scores than individual subjects who are untrained.

An analysis of covariance was conducted for each hypothesis in order to provide a more powerful statistical test, and to reduce the estimate of error variance (Keppel, 1982). The analysis was then completed by performing multiple *t*-test comparisons with the Bonferroni test for experimentwise error rate set at alpha =.01 on those groups found significant. The data reported in the next section is predicated on the hypotheses tested and will be discussed in detail for each hypothesis.

Hypothesis 1a

Three-way interactions with gender, pairing, and training were predicted for hypothesis 1a. Female pairs who received training were predicted to significantly outperform all groups. The adjusted gain score means and standard deviations for each of the eight groups are shown on Table 7. All groups had significant gains at the .0001 level. Although all groups were found to demonstrate significant gains, an analysis of covariance found no significant three-way interaction between the three independent variables [$F(1,79) = .49$, $p = .4882$] (see Table 8). Hypothesis 1a was therefore rejected.

Hypothesis 1b

In hypothesis 1b, untrained female pairs were expected to have significantly higher adjusted posttest scores than untrained male and female subjects who worked alone. Due to a lack of significant interaction effects with the three independent variables as mentioned in hypothesis 1a, hypothesis 1b was also rejected.

Hypothesis 2a

Female pairs were predicted to have higher adjusted posttest scores than male pairs regardless of training. The analysis showed female pairs had an adjusted posttest score mean of 14.1, and male pairs had an adjusted posttest score mean of 15.2. Although it appeared that male pairs had the

Table 8

Analysis of Covariance on Total Posttest Scores Using Pretest Scores as Covariate

Source	df	SS	MS	F	p
Pretest	1	7.89	7.89	0.79	.3766
Training	1	50.94	50.94	5.11	.0268
Gender	1	14.75	14.75	1.48	.2278
Pairing	1	44.86	44.86	4.50	.0374
Traini*Gender	1	20.66	20.66	2.07	.1544
Traini*Pairi	1	53.64	53.64	5.38	.0232
Gender*Pairi	1	1.65	1.65	0.17	.6858
Gender*Pair*Train	1	4.84	4.84	0.49	.4880
Error	71	707.61	9.97		
Total	79	911.55			

higher adjusted posttest score mean, that difference was not significant. There was no significant overall gender by pairing interaction found by the ANCOVA procedure [$\underline{F}$(1,$\underline{79}$)=0.17, p=.6558] (see Table 8). As such, Hypothesis 2a was not supported.

Hypothesis 2b

Male subjects who worked alone were hypothesized to have nonsignificant adjusted posttest score mean differences when compared to female subjects who worked alone, regardless of training. Although individual male subjects had the higher adjusted posttest score mean, the difference between the means of 16.5 and 15.9 did not make the two groups significantly different from each other. Therefore, Hypothesis 2b was accepted.

Hypothesis 3a

In hypothesis 3a, trained pairs were predicted to have a significantly higher adjusted posttest score mean than untrained individuals. The adjusted posttest score mean of 16.3 for trained pairs, was comparable to the adjusted posttest score mean of 16.2 for untrained individual subjects. The ANCOVA showed a significant interaction for pairing and training [$\underline{F}$(1,79)=5.38, $\underline{p}$=.0232] (see Table 8). However, a follow-up $\underline{t}$-test comparison of the two groups revealed no statistically significant differences between them (p=.9147) (see Table 9). Hypothesis 3a was rejected.

Hypothesis 3b

It was predicted that untrained pairs would have significantly higher adjusted posttest scores than those of trained individual subjects. The adjusted posttest score mean (13.0) of untrained pairs turned out to be significantly lower than 16.2, the adjusted posttest score mean for trained individuals. Subsequent *t*-test comparison showed a significant p-value of .0026 (see Table 10) in favor of trained individuals. Although the difference between the two groups turned out to be significant, it was in the opposite direction than predicted by hypothesis 3b. Thus, hypothesis 3b was also rejected.

Hypothesis 4a

Paired subjects who are trained are expected to score significantly higher than untrained pairs in the content-knowledge posttest. Both groups registered significant posttest gains after adjusting for the pretest (p=.0001). Of the two groups, trained pairs had a significantly higher adjusted posttest score mean of 16.3 (SD=3.0) while untrained pairs gained 13.0 (SD=3.0). The overall analysis of covariance showed significant main effects for training [$F(1,79)=5.11$, $p=.0268$] (see Table 8). However, this main effect has to be examined in light of an interaction with

Table 9

T-test Comparison Using Adjusted Posttest Score Means for Trained Pairs and Untrained Individuals

Group	POSTTEST LSMEAN	p
Trained Pairs	16.3	.9147
Untrained Individuals	16.2	

Table 10

T-test Comparison Using Adjusted Posttest Score Means for Untrained Pairs and Trained Individuals

Group	POSTTEST LSMEAN	p
Untrained Pairs	13.0	.0026
Trained Individuals	16.2	

pairing that was taking place. A pre-planned *t*-test comparison did show significant gain score mean differences sustained by trained pairs (p=.0017)(see Table 11). Thus, hypothesis 4a was supported.

Hypothesis 4b

Trained individual subjects were hypothesized to score significantly higher than untrained individual subjects in the posttest. Both groups made significant gains in their adjusted posttest scores after controlling for the pretest scores (p=.0001 for both groups). The adjusted posttest score means for the two groups were 16.2 (SD=3.0) and 16.2 (SD=3.0) respectively. In the overall ANCOVA, there was a significant main effect of training as noted in hypothesis 4a. Thus, a follow *t*-test was in order. However, in hypothesis 4b, training did not produce a significant effect between the two groups of subjects who worked individually. Thus, hypothesis 4b was rejected (p=.9767) (see Table 12).

Hypothesis 5a

In hypothesis 5a, when subjects were trained, pairs were predicted to perform significantly better than individual subjects. The analyses showed that pairs had an adjusted posttest score mean of 16.3 while individuals had an adjusted posttest score mean of 16.2. The adjusted posttest score means for the two groups demonstrated significant gains at the .0001 level for both groups.

Table 11

T-test Comparison Using Adjusted Posttest Score Means for Trained and Untrained Pairs

Group	POSTTEST LSMEAN	p
Pairs		
Trained	5.53	.0017
Untrained	2.27	

Table 12

T-test Comparison Using Adjusted Posttest Score Means for Trained and Untrained Individuals

Group	POSTTEST LSMEAN	p
Individuals		
Trained	16.2	.9767
Untrained	16.2	

Although the overall ANCOVA indicated a significant main effect for pairing [$F(1,79)=4.50$, $p=.0374$] (see Table 8 again), the main effect must be interpreted in light of the pairing and training interaction that is taking place. As can be seen from Table 13, a follow-up *t*-test comparison failed to indicate a significant difference between the adjusted posttest score means of trained pairs versus trained individuals ($p=.8903$). Thus, even though significant main effects were found for pairing, it did not hold true in hypothesis 5a which was ultimately rejected.

Hypothesis 5b

Untrained subjects who worked in pairs were expected to significantly outperform untrained subjects who worked alone on the posttest. Both groups did show significant adjusted posttest score means at $p=.0019$ and .0001 levels respectively. However, of the two untrained groups of subjects, those who worked alone had an adjusted posttest score of 16.2, higher than that of the paired group, whose adjusted posttest score was 13.0. Again, the significance of the main effect of pairing was evaluated in light of the training interaction that was taking place as discussed in hypothesis 5a above. A *t*-test comparison of the two groups did reveal significant differences between the two groups ($p=.0025$)(see Table 14).

Table 13

T-test Comparison Using Adjusted Posttest Score Means for Pairs and Individuals Who are Trained

Group	POSTTEST LSMEAN	p
Trained		
Pairs	16.3	.8903
Individuals	16.2	

Table 14

T-test Comparison Using Adjusted Posttest Score Means for Pairs and Individuals Who are Untrained

Group	POSTTEST LSMEAN	p
Untrained		
Pairs	13.0	.0025
Individuals	16.2	

However, the significance was found in favor of untrained individuals subjects, and the outcome turned out to be in the opposite direction than predicted by the original hypothesis. Therefore, hypothesis 5b was not supported.

CHAPTER V

Discussion

The study described here is of particular interest to those working with lower elementary-aged children using new computer technology that incorporates the use of laserdiscs. One hundred and twenty 2nd-graders were evaluated using their adjusted posttest scores on a content-knowledge test based on a high interest biology topic on primates. Scientific process skills of observation, comparing and contrasting, and classification were used for problem-solving. The use of 2nd-graders from two Guilford County public schools should allow the findings to be generalized to other public school populations with characteristics that are similar to those of the samples used.

This research explored three independent variables, pairing, training and gender, which determined the posttest score outcomes of a content-knowledge test based on a hypermedia science program about apes and monkeys. The works of Browning (1986) and Thorkildsen, et al. (1983) indicate that the use of hypermedia in education is generally effective in producing higher achievement scores. The positive effects of computer-assisted instruction on achievement has been well-documented for many subjects

(Hartley, 1978) and across a broad age range (Burns & Bozeman, 1982; Kearsley, Hunter, & Siedal, 1983).

Bloom (1976) posits that most students can learn if they are provided with the appropriate learning conditions. In this research study, subjects were trained to use systematic self-instruction strategy using verbalization to analyze, rehearse and remember information, and to work in pairs. In the cooperative learning literature, numerous studies attested to better and improved learning through structured collaboration than individual efforts (Sharan & Shachar, 1989; Slavin, 1990b). "Cooperative learning" is typically used in association with specific methods in which students are required to work together on a common goal or task (Slavin, 1987). Cooperative learning strategies have been found to produce positive outcomes in student achievement in the classroom (Slavin & Karweit, 1981; Sharon, 1980). In the cooperative learning literature using computers with groups, Johnson and Johnson (1986) concluded that "computer-assisted cooperative learning promoted ... longer retention of the material being learned" (p.15) among other things, than did computer-assisted individualistic learning.

The following summary of findings provides further information about a relatively young area of educational research using pairs and individual students working with high technology. Each of the four research questions addressed by this study and their related hypotheses will be discussed separately in the next section.

Summary of Findings

The outcomes of this study do not support most of my predictions, however they generally support those from studies that have been previously conducted using cooperative strategies, and computer technology with cooperative strategies. One of the most important findings points to the lack of significance of using training to effect higher adjusted posttest scores with individual subjects using this hypermedia program. The other finding of equal importance is the poor performance of pairs of subjects on the content-knowledge posttest when they are untrained.

Research Question One

"Are there significant gender differences in content-knowledge score outcomes between groups in different treatment conditions?"

The issue of gender differences has long been debated. Numerous findings point to the lack of statistical reasons to suspect any gender differences in achievement, especially in young elementary grade subjects (Nelson, et al., 1991; Chen, 1984). Nevertheless, this researcher chose to explore the possibility that gender differences might be present when subjects worked in pairs of the same sex on a hypermedia computer program such as the one used in this study. The expectation of possible gender differences between pairs of same-sex subjects is supported by significant differences found in other studies using single subjects on language-related computer tasks (Anderson, et al., 1979).

Hypothesis 1a. and 1b. No significant main effects for gender [$F(1,79)=1.48$, $p=.2278$), and no significant interaction effects for gender training, and pairing [$F(1,79)= .49$, $p=.4880$), gender and pairing [$F(1,79)= .17$, $p=.6858$), and gender and training ($p=.1544$) were found in this study. Hypothesis 1a was rejected because the expectation that female same-sex pairs would significantly outperform all other groups did not hold true. Hypothesis 1b was also rejected as a result of a significant but opposite outcome than was predicted by the original hypothesis in 1b. Untrained female pairs did not have significantly higher adjusted gain scores than untrained male or female individual subjects. Three-way interactions analyzed by the analysis of covariance showed no significant differences among all eight groups.

No gender differences were expected for individual subjects working alone, and no statistically significant differences were found. The results of hypotheses 1a and 1b confirm many studies that report no differences between males and females in cooperative behaviors especially around age 8 years (e.g., Crockenberg, Bryant, & Wilce, 1976; Stingle & Cook, 1989).

Hypothesis 2a. and 2b. No gender differences were found between pairs who were trained versus those who were untrained. Female pairs did not perform significantly better than male pairs ($p=.2553$). Although the hypothesis 2a prediction was predicated in part on positive findings by Underwood and Underwood (1990) who found girl pairs performing better on language-based computer tasks, the results of this study failed to show gender differences of a significant nature.

One possible reason for the lack of a significant difference between male and female pairs used in this study could be due to the design of the hypermedia program used. While the Underwood and Underwood (1990) study required same-sex pairs of subjects to use language abilities such as word-decoding skills in their computer program, the particular software in this case was entirely voice-read. As such, minimum reading skills were required from the subjects. In fact, the program had a built-in feature that allowed all subjects to hear any word or words as many times as they wanted. In the Underwood and Underwood, and Anderson, et al. studies, it is possible that the suspected language advantage that girls were found to possess were not utilized in the computer program in this research study.

Hypothesis 2b was accepted. No gender differences were expected for individual subjects working alone. As expected, there were no significant differences found between these two groups when gender was manipulated as the independent variable. This finding is congruent to the gender and computer learning literature using individual subjects (Nelson, et al., 1991).

On the whole, the findings in hypotheses 1a, 1b, and 2a, except for 2b, did not support the hypotheses set forth in research question one.

Research Question Two

"Will pairing and training combined significantly increase 2nd graders' content-knowledge posttest scores when compared to all other treatment conditions?"

Hypotheses 3a. and 3b. Although a significant pairing and training interaction was found [$F(1,79)=5.38$, $p=.0232$), both hypothesis 3a and 3b were rejected. Pre-planned t-test comparisons found that although the interaction was significant, three of the four groups contrasted for significant posttest gains did equally well. Pairs who were trained did not do differently than individuals who were trained, and individual subjects who were untrained. However, individual subjects did perform significantly better than untrained pairs. This finding is important for the pairing and training interaction. Findings in hypothesis 3a and 3b showed that untrained pairs did significantly less well than trained pairs and trained individuals. At first, it may seem that training itself was the cause of the difference between the groups compared. However, as will be further noted in the discussion of research question 3 following, the significant main effect of training on pairs must be interpreted in connection with the interaction that is taking place with pairing.

Research Question 3

"Does training alone produce significant content-knowledge gain score differences between different groups, except for combined pairing and training condition?"

Hypothesis 4, as a whole, was partially supported. There were significant main effects for training observed following the ANCOVA performed on the posttest scores [$F(1,79)=5.11$, $p=.0268$). Overall, training appeared to make a significant difference in score outcomes. However, closer examination of the specific groups addressed by hypothesis 4a and 4b signals caution in a blanket acceptance of hypothesis 4.

Hypothesis 4a. and 4b. In hypothesis 4a, it was predicted that pairs who were trained would significantly outperform pairs who were untrained. The outcome supported the prediction, and hypothesis 4a was accepted.

A likely explanation for the poor performance of untrained pairs (adjusted posttest score mean=2.272) could be that the children who were working with a partner, but untrained in a specific strategy, were likely to "goof-off" as were observed in some of the untrained pairs during the study. The untrained pairs exchanged remarks and comments on the visual stimuli that were mostly funny or intentional at making their partners laugh. For example, one of the untrained pairs was overheard to remark, "Hey, I can do that (child begins to get off the chair and acts like an ape)!" Slavin (1988), and Johnson and Johnson (1975) did find that just putting children together did not automatically result in children being able to accomplish tasks cooperatively. As such, according to these studies, the results found here were not unexpected.

The acceptance of hypothesis 4a confirms earlier studies cautioning the use of pairs of children to work on a similar task without providing some form of structure or guidance. Training in this study provided pairs with a specific task, and a strategy that helped them focus on information pertinent to their learning. Pairs who were untrained were not given this focus and common task. They were later observed to be engaged in other forms of behaviors that distracted them from the learning. The score outcomes speak to the advantage of having pairs work together only after some form of training or guidance is provided to help them focus on the learning at hand. Untrained pairs were only given cooperative efforts guidelines which included three rules for working together found in Figure 4. It would appear that cooperative rules may be insufficient, and that strategies for learning also are necessary for pairs working together.

Contrary to the researcher's expectations that untrained individuals would do less well than trained individuals, results for hypothesis 4b showed otherwise. There were no significant difference between the two groups ($p=.9767$). Thus hypothesis 4b was rejected.

One of the most surprising findings during the multiple t-test comparisons was the finding that untrained individuals did equally as well as trained individuals, and even compared favorably with pairs who were trained. The researcher offers the conclusion that perhaps the success of the untrained individual subjects can largely be attributed to the sound pedagogical design of the hypermedia software. The interactive video treatment given to all groups of individuals was carefully thought-through and designed by the Children and Technology Team at the University of North Carolina at Greensboro, and had the input of a local testing consultant who specializes in young elementary-aged children, a K-2 teacher with experience in Computer-Based Instruction, and the Computer Education Curriculum Specialist expert at the Guilford County Curriculum Center.

It is the belief of this researcher that the design of the interactive video program used was in itself an effective tool for promoting self-learning when individuals are working on the program, and that no training was necessary to effect learning. The insignificant difference between adjusted posttest score means of untrained individuals versus trained individuals speak to that.

One logical explanation for the lack of training effects on individual students working on this program would be the inherent strength of the software itself which seems to help students learn without any training. However, the strengths of this particular software has to be addressed in another study. This being a relatively young field, further research investigation is warranted. Another possible explanation could be attributed to the limitation of treatment time which was spread over only two days due to time constrains imposed by the schools as a result of the end of the school year when this stusy was conducted. It is possible that given a longer practice period, subjects which have been trained to use the strategies for content recall might be able to apply those strategies more effectively.

Research Question Four

"Does pairing alone produce significant differences between different groups?"

In hypothesis 5, it was predicted that pairing itself was as powerful a variable as training would be. This prediction was not supported. Individual subjects who received training did significantly better than untrained pairs. Apparently, training only made a difference when subjects had to work in pairs.

Hypotheses 5a. and 5b. Although main effects for pairing was observed [$F(1,79)=4.50$, $p=.0374$], hypotheses 5a was rejected. Trained pairs and trained individuals were not statistically different from each other. When training was controlled, pairing in this case did not appear to make a different between the two groups. A possible reason for the lack of significant difference between pairs and individuals who are trained could be that under the learning environment provided in this study, pairs were guided in the training strategy the same way as individuals. Apart from taking turns with their partners on the mouse, and the interaction during recall and answer of questions outlined in the cue cards, pairs did not engage in additional learning behaviors such as increased oral discussion of the material learned. This finding seemed to be congruent to a number of studies that found little support that peer interaction in itself would result in increased achievement among students (Slavin, 1987). In most cooperative studies, success with groups have been found with the use of group rewards (Slavin, 1980). Perhaps the use of a reward for learning the material might have an increased effect on pairs learning together. However, this needs added investigation through further research.

In hypothesis 5b, there was a significant difference found between pairs who were untrained and individuals who were untrained. However, hypothesis 5b was still rejected because the finding turned out to be in the opposite direction than predicted. Untrained individuals performed significant better on the content-knowledge posttest than the untrained pairs did. This finding points to the lack of a training effect when pairs and individuals are compared. Rather, it points to the interaction that is taking place with pairing and training. The fact that untrained individuals did better than untrained pairs leads one to conclude that under such conditions, if training is not given, then students should work alone on the hypermedia program similar to the one used in this study. Putting pairs of subjects together without providing them with training appeared to have interfered with their learning of the content as was reflected in the lower adjusted posttest score mean of untrained pairs.

Again, without the training, individuals were able to focus on the program and pick up information pertinent to the test. However, the distraction of working with a partner may have reduced the amount of gain made on the posttest for untrained pairs. Thus both Hypothesis 5a and 5b were rejected.

Limitations

This study has several limitations. First, the findings were limited by the validity of the testing instrument used. The test was constructed using information from a pilot study using a posttest-only experimental-control group design in which 38 subjects answered 79 test items on paper and pencil. The final 25-item test was then administered to the 120 subjects in this study on computer. Thus, the validity of the testing instrument depended on the test items themselves.

Second, intact 2nd-grade classrooms chosen by the respective school principals were used, although all subjects were randomly assigned to one of eight treatment conditions. While the sample used was not atypical of the student population within the Guilford County School System, findings may only be generalizable to similar student populations within the same geographic area, and with similar characteristics as the sample used. Thirdly, the study contained a one-shot training and pretest-posttest design using content matter which could be comfortably stretched out over several weeks. Thus, it is suggested that with such designs, repeated measures over time might be more sensitive to the learning that might be taking place with different groups of subjects under differnt treatment conditions. The number of subjects per cell was a limitation. It is recommended that replication should be done with a larger sample per cell.

Conclusions

Perhaps the strongest conclusion that can be drawn from this study is the fact that untrained individuals, regardless of sex, can perform as well as trained individuals on hypermedia lessons similar to the one used in this study. Although pairs and individuals who were trained also had significant gains, their gains were not significantly different from untrained individuals, a group originally predicted to do the worst by this researcher.

As mentioned before, one logical conclusion may be that the design of the interactive video software program--Primates--could be of high quality, resulting in self-learning without training where individuals are concerned. However, before such a strong statement can be made, further research using this and other similarly designed programs need to be conducted to ascertain the effectiveness of hypermedia computer instruction with young elementary-aged children. In addition, the length of treatment time may also have an impact on the amount of strategy use on groups who were trained. In this study, training was given over two days which may not be sufficient for any learning to take place. Future studies should incorporate a longer treatment over time.

Another significant conclusion from this research has to do with putting pairs of students at the computer. As the results suggested, when pairs of students are working on a hypermedia software program, providing them with some kind of strategy or instruction like the one used in this study increases their performance on a test of content-knowledge.

In short, one may summarize that when using hypermedia instruction similar in design to the Primates program, it may not be necessary to provide individual subjects with strategies like the one used in this research study. However, when using pairs of subjects, some form of guided learning that helps them focus on the task may be likely to produce better results. In this study, the systematic self-instruction strategy using overt verbalization was able to help pairs focus their attention on important task features rather than on irrelevant information.

Implications for Future Research

Learning to think as well as learning content are closely related. In addition, learning should be dynamic, and should accommodate and address differences in students' abilities. In future studies, it is suggested that problem-solving skills and transfer skills be examined in addition to content mastery when using hypermedia programs. Also, a no-treatment control group should be included to ascertain the effects of hypermedia programs like the one used in this study. Comparisons between individual subjects who received and did not receive training may be reinvestigated using a different learning strategy. I would also recommend a longer treatment period in future studies that examine whether differences between groups are maintained over time.

In terms of using cooperative pairs of subjects, the use of mixed-gender pairs could be explored to revisit the gender question. Alternatively, one could also look at pair combinations of mixed pairs by competency level, i.e., pairing high ability students with middel ability and low ability students and pairing middel ability students with high ability students. Other possible lines of research that could follow from this study could be conducted using Vygotskian theory of matching novice learners to expert teachers by using teacher-scaffolding versus self-instruction, or using teacher-scaffolding with pairs versus with individual students. Additionally, cooperative groups versus competitive groups consisting more than two students could also be examined. Finally, one could also compare hypermedia treatments with traditional computer-assisted programs using the treatment conditions outlined in this study.

BIBLIOGRAPHY

Adams, D., Carlson, H., & Hamm, M. (1990). Cooperative learning and educational media: Collaborating with technology and each other. Engelwood Cliffs, New Jersey: Educational Technology Publications.

Adams, A., Carnine, D., & Gerstein, R. (1982). Instructional strategies for studying content area text in the intermediate grades. Reading Research Quarterly, 18(1), 27-55.

Ahlgren, A., & Johnson, D. (1979). Sex differences in cooperative and competitive attitudes from the 2nd through the 12th grades. Developmental Psychology, 15, 45-49.

Alridge, B. (1989). Essential changes in science: Scope sequence and coordination. NSTA Reporter.

Anderson, R., Klassen, D., Kohn, K., & Smith-Cunnien, P. (1979). Assessing computer awareness and literacy: An empirical assessment. Minnesota Educational Computing Consortium, Minneapolis, 1982.

Asarnow, J. R., & Meichenbaum, D. (1979). Verbal rehearsal and serial recall: The mediational training of kindergarten children. Child Development, 50, 1173-1177.

Atkinson, R., & Schiffrin, R. (1968). Human memory: A proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds), The psychology of learning and motivation: Advances in research and theory, Vol. 2. New York: Academic Press.

Azmitia, M. (1988). Peer interaction and problem-solving: When two heads are better than one? Child Development, 59, 87-96.

Babbs, P. (1984). Monitoring cards help improve comprehension. The Reading Teacher, 38, 200-204.

Baker, L., & Brown, A. L. (1984). Metacognitive skills and reading. In P. D. Pearson (Ed.), Handbook of reading research, (pp. 353-394). New York: Longman.

Bandura, A. (1989). Social cognitive theory. In P. Vasta (Ed.), Annals of child development, Vol. 6, pp. 1-60. Greenwich, CT: Jai Press, Inc.

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, New Jersey: Prentice-Hall.

Barba, R. H., & Armstrong, B. E. (1992). The effect of hypercard and interactive video instruction on earth and space science students' achievement. Journal of Educational Multimedia and Hypermedia, 1(1), 323-330.

Barnes, B. J., & Hil, S. (1983). Should young children work with microcomputers? The Computing Teacher, 10, 10-14.

Barry, H., Bacon, M., & Child, E. (1957). A cross-cultural study of some sex differnces in socialization. Journal of Abnormal and Social Psychology, 55, 326-332.

Berliner, D. C., & Rosenshine, B. V. (1976). The acquisition of knowledge in the classroom. (Beginning Teacher Evaluation Study Report Series). San Francisco: Far West Laboratory for Educational Research and Development.

Bloom, B. S. (1956). Taxonomy of educationa objectives:The classification of educational goals. New York: Longmans, Green.

Bloom, B. S. (1976). Human characteristics and school learning. McGraw-Hill.

Bosco, J. W. (1986). An analysis of evaluations of interactive video. Educational Technology, 26(2), 7-17.

Broverman, I. K., Broverman, D. M., Clarkson, F. E., Rosenkrantz, P. S. & Vogel, S. R. (1970). Sex role stereotypes and clinical judgemnts of mental health, Journal of Consulting and Clinical Psychology, 34, 1-7.

Brown, A. L., & Smiley, S. S. (1978). The development of strategies for studying texts. Child Development, 49, 1076-1088.

Browning, P. (1986). Interactive video in the special classroom: A pilot study. The Computing Teacher, 13, 36-38.

Carli, L. L. (1989). Gender differences in interaction style and influence. Journal of Personality and Social Psychology, 56(4), 565-576.

Carlson, H., & Falk, D. (1986). Learner analysis for interactive videodisc instructional design: Understanding groups videodisc series. Duluth, MN: Center for the Advancement of Learning Technologies Interactive Videodisc Research Groups, Occasional Paper 87-2.

Carlson, H. L., & Falk, D. R. (1989). Effective use of interactive videodisc instruction in understanding and implementing cooperative group learning with elementary pupils in social studies. Theory Research in Social Education, 17(3), 241-258.

Carment, D. W. (1974). Effect of sex role in a maximizing difference game. Journal of Conflict Resolution, 18, 461-472.

Clements, D. H. (1987). Computers and young children: A review of research. Young Children, 42, 34-44.

Clements, D. H., & Gullo, D. F. (1984). Effects of computer programming on young children's cognition. Journal of Educational Psychology, 76, 1051-1058.

Cole, M., & Griffin, P. (1987). Contextual factors in education: Improving science and mathematics education for minorities and women. Madison: Wisconsin Center for Educational Research.

Corno, L., & Mandinach, E. B. (1983). The role of cognitive engagement in classroom learning and motivation. Educational Psychology, 18, 88-108.

Crokenberg, S. B., Bryant, B. K., & Wilce, L. S. (1976). The effects of cooperatively and competitively structured learning environments on interpersonal behavior. Child Development, 47, 386-396.

Cuffaro, H. K. (1984). Microcomputers in education: Why is earlier better? Teachers College Record, 85, 559-568.

Culley, L. (1988). Girls, boys and computers. Educational Studies, 14, 3-8.

Dede, L. (1983). The likely evolution of computer use in schools. Educational Leadership, 41, 22-24.

DeVries, D. L., Edwards, K. J., & Wells, E. H. (1974). Teams-games-tournaments in the social studies classroom: Effects on academic achievement, student attitudes, cognitive beliefs, and classroom climate. Report #173, Center for social Organization of Schools, John Hopkins University.

Eastman, S. T., & Krendle, K. (1987). Computers and gender: Differential effects of electronic search on students' achievement and attitudes. Journal of Research and Development in Education, 20, 41-48.

Edwards, K. J., DeVries, D. L. (1972). Learning games and student teams: Their effects on student attitudes and achievement. Report #147, Center for social Organization of Schools, John Hopkins University.

Elkind, D. (1987). Miseducation: Preschoolers at risk. New York: Alfred A. Knopf.

Evans, A. D. (1985). Interactive video reserach: Past studies and directions for future research. International Journal of Instructional Media, 13(3), 241-248.

Flavell, J. H., Beach, D. R., & Chinsky, J. M. (1966). Spontaneous verbal rehearsal in a memory task as a function of age. Child Development, 37, 283-299.

Fuson, K. C. (1979). The development of self-regulating aspects of speech: A review. In G. Zivin (Ed.), The development of self-regulation through private speech, (pp. 135-217). New York: Wiley.

Ghatala, E. S., Levin, J. R., Pressley, M., & Lodico, M. G. (1985). Training cognitive strategic-monitoring in children. American Educational Research Journal, 22(2), 199-215.

Golton, R. F. (1975). The effects of student interaction on computer instruction in mathematics at the 6th grade. Doctoral Dissertation, University of California, Berkeley, CA.

Gray, M. J. (1987). Comprehension monitoring: What the teacher should know. The Clearing House, 61, 39-41.

Hannafin, M. J. (1985). Empirical issues in the study of computer-assisted interactive video. Educational Communications and Technology Journal, 33, 235-247.

Heller, R. S. (1990). The role of hypermedia in education: A look at the research issues. Journal of Research on Computing in Education, 22(4), 431-441.

Henderson, R. W. (1986). Self-regulated learning: Implications for the design of insructional media. Contemporary Educational Psychology, 11, 405-427.

Hertz-Lazarowitz, R., & Shachar, H. (1990). Teachers' verbal behavior in cooperative and whole class instruction. In S. Sharan (Ed.), Cooperative learning: Theory and research. New York: Praeger.

Hofmeister, A. M., Engelmann, S. & Carnine, D. (1989). Developing and validating science education videodiscs. Journal of Research in Science Teaching, 26(8), 665-678.

Hueftle, S. J., Rakwo, S. J., & Welch, W. W. (1983). Images of science: Science assessment and research project. University of Minnesota.

Hughes, M., & Greenhough, P. (1989). Gende and social interaction in early LOGO use. In J. H. Collins, N. Estes, W. D. Gattis, & D. Walker (Eds.), The Sixth International Conference on Technology and Education, Vol. 1, Edinburgh: CEP.

Humphreys, B., Johnson, R. T., & Johnson, D. W. (1982). Effects of cooperative, competitive and individualistic learning on students' achievement in science classes. Journal of Research for Science Teachers, 19, 351-356.

Johnson, D. W., & Johnson, R. T. (1975). Learning together and alone: Cooperation, competition, and individualization. New Jersey: Prentice-Hall.

Johnson, D. W. & Ahlgren, A. (1976). Relationship between student attitudes about cooperation and competition and attitudes towrad schooling. Journal of Educational Psychology, 68, 92-102.

Johnson, D. W., Johnson, R. T., & Scott, L. (1978). The effects of cooperative and individualized instruction on student attitudes and achievement. Journal of Social Psychology, 104, 207-216.

Johnson, D. W., & Johnson, R. T. (1983). The socialization and achievement crisis: Are cooperative learning experiences the solution? In L. Bickman (Ed.), Applied Psychological Annual 4. Beverly Hills, Calif.: Sage Publications.

Johnson, D. W., & Johnson, R. T. (1983). What research says about student-student interactions in science classrooms. In M. Rowe (Ed.), Education in the 80s: Science (pp. 25-27). Washington, DC: National Education Association.

Johnson, D. W., Johnson, R. T., Holubec, E. J., & Roy, P. (1984). Circles of learning: Cooperation in the classroom. ASCD Publication.

Johnson, D. W., & Johnson, R. T. (1985a). Cooperative learning: One key to computer-assisted learning. The Computer Teacher, Oct., 11-15.

Johnson, R. T., Johnson, D. W., & Stanne, B. (1985b). Effects of cooperative, competitive and individualistic goal structure on computer-assisted instruction. Journal of Educational Psychology, 77(6), 668-677.

Johnson, D. W., & Johnson, R. T. (1986a). Computer-assisted cooperative learning. Educational Technology, Jan., 12-18.

Johnson, R. T., Johnson, D. W., & Stanne, B. (1986b). Comparison of computer-assisted cooperative, competitive and individualistic learning. American Educational Research Journal, 23(3), 382-392.

Jones, P. (1989). What multimedia means to learning. Technological Horizons in Education Journal, Annual Macintosh Special Edition, 16-17.

Keeney, T. J., Cannizzo, S. R., & Flavell, J. H. (1967). Spontaneous and induced verbal rehearsal in a recall task. Child Development, 38, 953-966.

Keppel. G. (1982). Design and analysis: A researcher's handbook. Englewood Cliffs, New Jersey: Prentice HAll, Inc.

Kulick, J. A., Kulick, C. C., & Bangert-Downs, R. L. (1985). Effectiveness of computer-based education in elementary schools. Computers in Human Behavior, 1, 59-74.

Lepper, M. R. & Gurtner, J. (1989). Children and computers: Searching the 21st Century. American Psychologist, 44(2), 170-178.

Levin, J. R., Ghatala, E. S., Derose, T. M., Wilder, L., & Norton, R. W. (1975). A further comparison of imagery and vocalization strategies in children's discrimination learning. Journal of Educational Psychology, 67, 141-145.

Levin, J. R., Ghatala, E. S., Wilder, L., & Inzer, E. (1973). Imagery and vocalization strategies in children's discrimination learning. Journal of Educational Psychology, 64, 360-365.

Litchfield, B. C., & Mattson, S. A. (1989). The interactive media science project. Journal of Computers in Mathematics and Science Teaching, 9(1), 37-44.

Lucas, L. (1992). Interactivity: What is it and how do you use it? Journal of Educational Multimedia and Hypermedia, 1(1), 7-10.

Maier,N. & Casselman, G. (1970). The Psychology of sex differences. Palo Alto, CA: Standford University Press.

Mandinach, E. B., & Corno, L. (1985). Cognitive engagement variations among students of different ability level and sex in a computer problem-solving game. Sex Roles, 13(3/4), 241-251.

Marchionini, G. (1988). Hypermedia and learning: Freedom and chaos. Educational Technology, Nov., 8-12.

Marsh, E. J., & Kumar, D. D. (1992). Hypermedia: A conceptual framework for science education and a review of recent findings. Journal of Educational Multimedia and Hypermedia, 1, 25-37.

Mevarech, Z. R. (1985). Computer-assisted different instructional methods: A factorial experiment with mathematics disadvantaged classrooms. Journal of Experimental Education, 54, 22-27.

Mevarech, Z. R., Stern, D., & Levita, I. (1987). To cooperate or not to cooperate in CAI: That is the question. Journal of Educational Research, 80(3), 164-167.

Miller, G. E., & Emihovich, C. (1986). The effects of mediated programming instruction on preschool children's self-monitoring. Journal of Educational Computing Research, 2(3), 283-297.

Miller, G. E., & Pike, S. (1973). Sex, matrix variations, and perceived personality effects in mixed-motive games. Journal of Conflict Resolution, 17, 335-349.

Miller, G. A. (1957). The magical number seven, plus or minus two: Some limits on our capacity for processing information. New York:Basic Books.

Nelson, C. S., & Watson, J. W. (1990). The computer gender gap: Children's attitudes and, performance and socialization. Journal of Educational Technology Systems, 19(4), 345-353.

Nelson, C. S., & Watson, J. A. (1991). Multimedia and repurposed interactive videodisc courseware: The means to teacher authored content-rich learning materials. Journal of Interactive Instruction Development, Win, 10-15.

Neter, J., Wasserman, W., & Kutner, M. H. (1985). Applied linear statistical models: Regression, analysis of variance, and experimental designs. Homeward, IL: Irwin.

Newmann, F. M., & Thompson, J. (1987). Effects of cooperative learning on achievement in secondary schools: A review of research. Madison, Wisconsin:

University of Wisconsin, National Center on Effective Secondary Schools.

Nickerson, R. S., & Zodhiates, P. P. (1988). Technology in education: Looking towards 2020. New Jersey: Lawrence Erlbaum.

Noell, J., & Carnine, D. (1989). Group and individual computer-based video instruction. Educational Technology, 29(1), 36-37.

Palincsar, A., David, Y., Winn, J., & Stevens, D. (1991). Examining the context of strategy instruction. Remedial and Special Education, 12(3), pp. 43-53.

Papert, S. (1980). Mindstorms: Children, computers and powerful ideas. New York: Basic Books.

Paris, S. G., Lipson, M. Y., & Wixson, K. K. (1983). Becoming a strategic reader. Contemporary Educational Psychology, 8, 293-316.

Piaget, J., & Inhelder, B. (1976). The psychology of the child. New York: Basic Books.

Pollack, R. A. (1989). The state of videodiscs in education and training. Instruction Delivery Systems, 4, 12-14.

Reese, H. W. (1962). Verbal mediation as a function of age level. Psychological Bulletin, 59, 501-509.

Ridgeway, C. (1978). Confromity, group-oriented motivation, and status attainment in small groups. Social Psycholgy, 41, 175-188.

Robinson, F. P. (1941). Diagnostic and remedial techniques for effective study. New York: Harper and Brothers.

Rumelhart, D. E. (1977). Introduction to human infromation processing. New York: John Wiley and Sons.

Salomon, G., & Clark, R. E. (1977). Reexamining the methodology of media and technology in education. Review of Educational Research, 47(1), 9-12.

Sarason, S. (1983). Schooling in America: Scapegoat and salvation. New York: The Free Press.

Schaffer, L. C., & Hannafin, M. J. (1986). The effects of progressive interactivity on learning from video. Educational Communications and Technology Journal, 34(2), 89-96.

Schunk, D. H. (1986). Verbalization and children's self-regulated learning. Contemporary Educational Psychology, 11, 347-369.

Seal-Warner, C. (1988). IOnteractive videosystems: Their promises and educational potential. Teachers College Record, 89(3), 373-383.

Sharan, S., & Shachar, H. (1988). Language and learning in the cooperative classroom. New York: Springer-Verlag.

Sharan, S. (1980). Cooperative learning in small groups: Recent methods and effects on achievement, attitude and ethnic relations. Review of Education Research, 50, 241-271.

Sheingold, K., Kane, J. H., & Endreweit, M. E. (1983). Microcomputers use in schools: Developing a research agenda. Harvard Educational Review, 58(4), 412-432.

Sheingold, K. (1988). The microcomputer as a symbolic medium. In P. F. Campbell & C. G. Fein (Eds.), Young children and microcomputers, pp. 25-34. Englewood Cliffs, New Jersey: Prentice-Hall.

Sheingold, K., & Tucker, M. (1990). Restructuring for learning with technology. Center for Technology in Education and the National Center on Education and the Economy.

Siann, G., & Macleod, H. (1986). Computers and children of primary school age: Issues and questions. British Journal of Educational Technology, 17, 133-144.

Simsek, A., & Tsai, B. (1992). The impact of cooperative group composition on student performance and attitudes during interactive videodisc instruction. Journal of Computer-Based Instruction, 19(3), 86-91.

Slavin, R. (1980a). Cooperative learning. Review of Educational Research, 50, 315-342.

Slavin, R. (1980b). Effects of student teams and peer tutoring on academic achievement and time-on-task. Journal of Experimental Education, 48, 252-257.

Slavin, R. (1988). Cooperative learning and student achievement. Educational Leadership, 46(2), 31-33.

Slavin, R. (1990a). Cooperative learning: A perspective on research and practice. In S. Sharan (Ed.), Cooperative learning: Theory and research. New York: Praeger.

Slavin, R. (1990b). Cooperative Learning: Theory, research and practice. Boston: Allyn & Bacon.

Slavin, R. E. (1987). Develomental and motivational perspectives on cooperative learning: A reconciliation. Child Development, 58, 1161-1167.

Slavin, R. E., & Karweit, N. L. (1981). Cognitive and affective outcomes of an intensive student team learning experience. Journal of Experimental Education, 50, 29-35.

Spivack, G., Platt, J., & Shure, M. (1976). The problem-solving approach to adjustment. San Francisco: Jossey-Bass.

Stallings, J. (1980). Allocated academic learning time revisited, or beyond time on task. Education Research, 9, 11-16.

Stanton, N., & Baber, C. (1989). An investigation of styles and strategies in self-directed learning. Journal of Educational Multimedia and Hypermedia, 1(1), 147-167.

Steinkamp, M., & Maehr, M. (1987). Gender differences in motivational orientation toward achievement in school science: A quantitative analysis. American Educational Research Journal, 21, 39-59.

Stendler, C., Damrin, D., & Haines, A. (1951). Studies in cooperation and competition: The effects of working for group and individual rewards on the social climate of children's groups. Journal of Genetic Psychology, 79, 173-179.

Stevens, D. J., Zech, L., & Katkarant, C. (1987). The classroom applications of an interactive videodisc high school science lesson. Journal of Computers in Mathematics and Science Teaching, 7(3), 20-26.

Stingle, S. & Cook, H. (1989). Age and sex differences in cooperative and noncooperative pairs of American Children. The Journal of Psychology, 119(4), 335-345.

Swadner, M. & Hannafin, M. (1987). Gender similarities and differences in 6th graders' attitudes towards computers: An exploratory study. Educational Technology, Jan, 37-42.

Swick, K. J. (1989). Appropriate uses of computers with young children. Educational Technology, Jan., 7-13.

Thorkildsen, R., Allard, K., & Reid, B. (1983). The interactive videodisc for special education project: Providing CAI for the mentally retarded. The Computing Teacher, 10(8), 73-76.

Underwood, G., McCaffrey, M., & Underwood, J. (1990a). Gender differences in a cooperative computer-based language task. Educational Research, 32, 16-21.

Underwood, J. D., & Underwood, G. (1990b). Computers and learning: Helping children aqcuire thinking skills. Cambridge: Basil Blackwell, Inc.

Watson, J. A., Nida, R. E., & Shade, D. D. (1986). Educational issues concerning young children and microcomputers: Lego with Logo. Early Childhood Development and Care, 23, 299-316.

Watson, J. A., Meshot, C. J., & Hagaman, W. H. (1988). Repurposing: The best chances for videodisc in education? Instructional Delivery Systems, 2(6), 11-14.

Watson, J. A., Nelson, C. S., Meshot, C. J., & Hagaman, W. H., & Busch, J. C. (1989). A hypermedia student workstation: Sea Mammals-A new way to teach young children to classify animals. Journal of Interactive Instruction Development, 1(4), 4-7.

Webb, N. M. (1982). Student interaction and learning in small groups. Review of Educational Research, 52, 421-445.

Webb, N. M. (1984). Microcomputer learning in small groups: Cognitive requirements and group processes. Journal of Educational Psychology, 76, 1076-1088.

Weiss, I. (1986). The 1985 national survey of science and mathematics education. In Background materials for forum 1986: The science curriculum. Office of Science and Technology Education, AAAS.

Whimbey, A., & Whimbey, L. (1975). Intelligence can be taught. New York: Innovative Science.

Yager, S., Johnson, D. W., & Johnson, R. T. (1985). Oral discussion, group-to-individual transfer, and achievement in cooperative learning groups. Journal of Educational Psychology, 77(1), 60-66.

Yager, S., Johnson, D. W., Johnson, R. T., & Snider, B. (1986). The impact of group processing on achievement in cooperative learning groups. Journal of Social Psychology, 126(3), 389-397.

Yates, B. C., & Moursund, D. (1989). The computer and problem-solving: How theory can support classroom practice. The Computing Teacher, 16(4), 12-16.

Zajonc, R. B. (1980). Feeling and thinking: Preferences need no inferences. American Psychologist, 35, 151-175.

Zsiray, S. W., Goodey, L. R., Godfrey, M. L., & Larson, L. L. (1987). Ventures with videodiscs. Science Scope, 10(4), 11-12.

APPENDIX A

CONSENT FORM

Letter to Parents

Dear Parent/Guardian,

Your child has been selected at random to participate in a study using state-of-the-art computers!

This study is designed to evaluate how well second graders master the content of a hypermedia science program which uses laserdiscs and computers. Selected children will be trained to use a self-instruction strategy to help them learn information presented on the computer in a systematic way. Some of the children, randomly assigned to work with a partner, will also be taught how to use cooperative rules to work as a team. The children who will be participating in this study will be administered a short test before and after the hypermedia science program in order to determine how much learning has taken place.

This study will be conducted over a 4-week period. Your child will be out of class a total of four 45-minute sessions over a 1-week period. All testing and instruction will be carried out in the school during these sessions. A trained adult will be with your child at all times when he/she is out of the classroom and involved in this study. The results of this study will in no way affect your child's grades in school.

Please indicate whether your child may participate in this study, and return the attached form **the next day** to the classroom teacher. You or your child may choose to stop participation at any time during the study.

Thank you.

Jane YinLeng Kwan-Ching, Doctoral Candidate

Department of Human Development and Family Relations

University of North Carolina at Greensboro

Permission To Participate In Study

Child's Name ________________________________

______ **My child will be participating in this study.**

______ My child will not be participating in this study.

Parent's/Guardian's Signature ________________________________

(Please check)

______ I would like a copy of the summary of study from my child's teacher.

Jane YinLeng Kwan-Ching, Doctoral Candidate
Department of Human Development and Family Relations
University of North Carolina at Greensboro

APPENDIX B

SAMPLE GROUP SCHEDULE

HYPERMEDIA SCIENCE LESSON

Teacher: ____________________

Date: **Monday, May 3, 1993 (first half)**

	pretest	pretest	pretest
Time Period:	Student Name:	Student Name:	Student Name:
8:00 - 8:30			
8:30 - 9:00			
9:00 - 9:30			
9:30 - 10:00			

Date: **Tuesday, May 4, 1993**

	pretest	pretest	pretest	pretest	Sea
Time Period:	Student Name/ ID:	Student Name/ ID:	Student Name/ ID:	Student Name/ ID:	Student Name/ ID:
8:00 - 8:30					
8:30 - 9:00					
9:00 - 9:30					
9:30 - 10:00					
10:00 - 10:30					
10:30 - 11:00					

APPENDIX C

COMPUTERIZED TEST ITEMS

1. The proboscis monkey has a

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

☞

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

   a. not very scientific
   b. called justification
   c. called classification

☞

3. Primates are

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

☞

4. Apes and monkeys are

   a. alike in all ways
   b. different in all ways
   c. alike in some ways and different in others

☞

5. Locomotion means

   a. where something is
   b. how something acts
   c. how something moves

☞

6. Chimpanzees are apes with flat noses like a

   a. gorilla's
   b. guereza's
   c. baboon's

☞

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

   a. orangutan
   b. guereza
   c. gibbon

☞

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

☞

9. Both monkeys and apes have tails.

Agree Disagree

don't know

10. Monkeys like to walk on their knuckles.

Agree Disagree

don't know

11. Apes have noses that are long and skinny.

Agree Disagree

don't know

12. Monkeys have noses with wide, flat openings.

Agree Disagree

don't know

13. Orangutans have tails.

Agree Disagree

don't know

14. The probosics monkey has a flat nose.

Agree Disagree

don't know

15. Apes and monkeys are kinds of primates.

Agree Disagree

don't know

16. A proboscis monkey is really an ape.

Agree Disagree

don't know

17. Ape and monkey noses look

Alike Different

don't know

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

Alike Different

don't know

19. The way that apes and monkeys locomote is

Alike Different

don't know

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

Alike Different

don't know

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

Alike Different

don't know

22. Is this

An Ape A Monkey

don't know

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

Agree Disagree

don't know

24. The orangutan is

An ape A monkey

don't know

25. The ring-tailed lemur is

An ape

A monkey

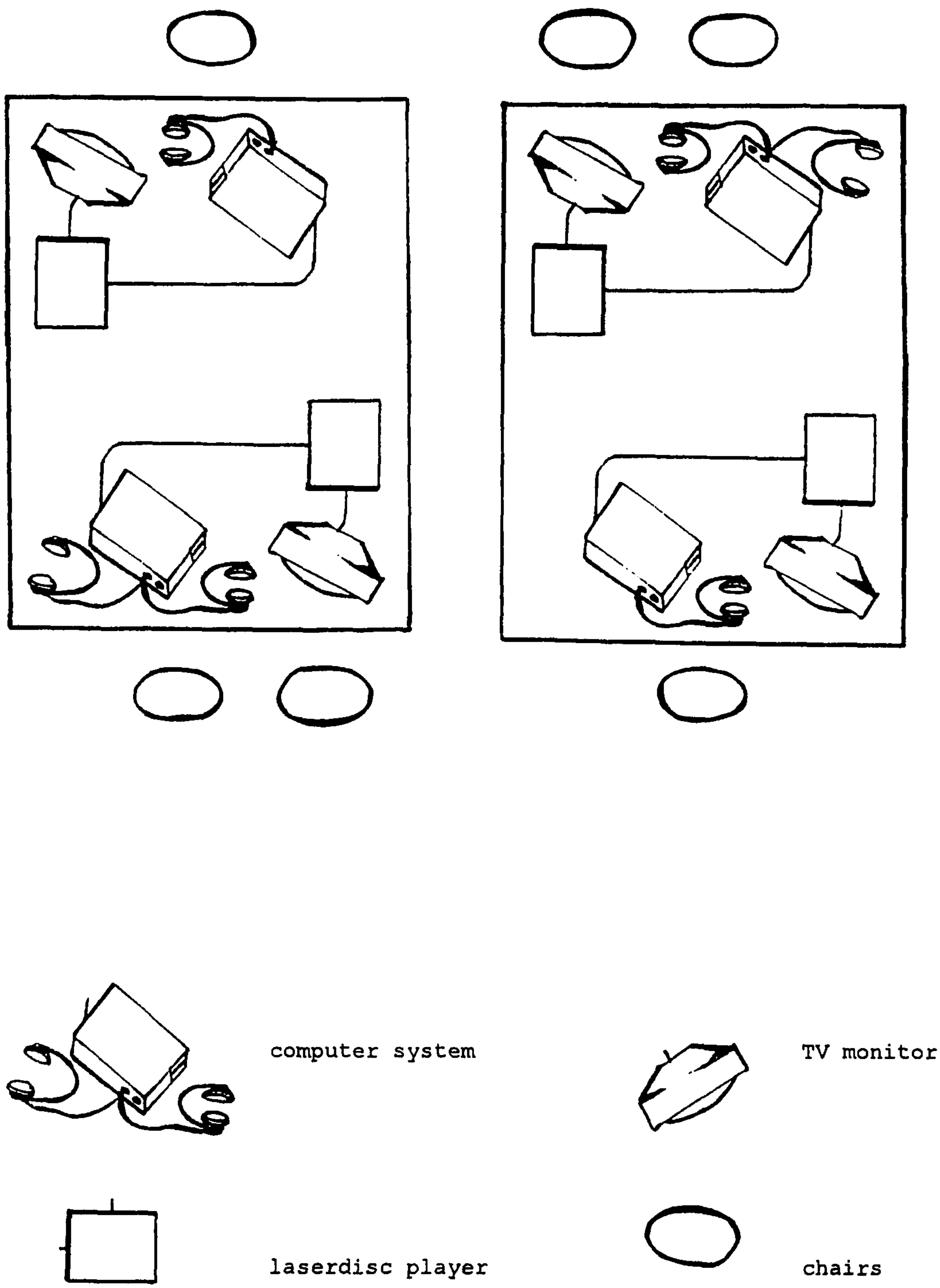
don't know

Good Work!

and Thank You!

APPENDIX D

HYPERMEDIA WORKSTATION SETUP


computer system
TV monitor
laserdisc player
chairs

APPENDIX E

PROTOCOLS FOR TRAINER

PROTOCOL FOR TRAINED GROUP (DAY 1)

1. " Today we are going to learn about whales".

2. "There are 3 things we are going to find out about whales:

   (Show chart)

   - where they live
   - the largest
   - how they breathe

3. "Can you look at these and memorize them?

   Now, can you tell me the 3 things?

   (If child has difficulty remembering, show chart again)

   (repeat till child is able to recall without looking at chart)

4. "When you go to the computer, you will look for information that helps you know :

   - where whales live?
   -which is the largest whale?
   - how do whales breathe?

5. (When child is at the computer), say:

   "Remember what 3 things about whales you are going to look at?"

6. (After each topic), ask:

   - "So, where do whales live?"

   - "So, which is the largest whale?"

   - "So, how do whales breathe?"

7. (At the end of the program), ask:

   - "Can you remember the 3 things about whales?"

   (Child should review without looking.)

PROTOCOL FOR TRAINED GROUP (DAY 2)

1. "This morning we are going to learn about Primates. We will learn about two kinds of primates--apes and monkeys."

2. Ask: "What 2 kinds of primates are we going to learn about?"

3. "We are going to find out 3 things about apes and monkeys are alike in, and 3 things that they are different in."

   "The 3 things apes and monkeys are alike in are:
   - what they eat
   - how their hands work
   - how their arms work"

4. (Show chart)

   "Can you look at these and memorize them like you did with the whales yesterday?
   Now, can you tell me the 3 things?"
   (If child has difficulty remembering, show chart again)
   (repeat till child is able to recall without looking at chart)

5. "Now the 3 things apes and monkeys are different in are:
   - their noses
   - their rears

- their locomotion

6. (Show chart)

"Can you look at these 3 things and memorize them?

Now can you tell me the 3 things that are different about apes and monkeys?"

(If child has difficulty remembering, show chart again)

(repeat till child is able to recall without looking at chart)

7. "When you go to the computer, you will look for information that will help you know:

- what do apes and monkeys eat?
- how do their hands work?
- how do their arms work?
- how does an ape's nose look?
- how does a monkey's nose look?
- how does an ape's rear look?
- how does a monkey's rear look?
- how does an ape locomote?
- how does a monkey locomote?

8. (At alike and different screen), ask:

"What 3 things are apes and monkeys alike in?

What 3 things are apes and monkeys different in?

9. (After each topic, have partner ask):

- "so, what do apes and monkeys eat that is alike?"
- " so, how do apes' and monkeys' hands work that is alike?"
- "so, what do apes' and monkeys' arms look like that is alike?"
- "so, how does an ape's nose look like?"
- "so, how does a monkey's nose look like?
- "so, how does an ape's rear look like?
- "so, how does a monkey's rear look like?
- "so, how does an ape locomote?
- "so, how does a monkey locomote?

10. (At end of program, have partners recall the 3 things that apes and monkeys are alike and different in. Children should be able to recall without looking at chart. If not, let them refer to chart until they can recall without prompting.)

APPENDIX F

PROTOCOLS FOR EXPERIMENTERS

Role of Observers

* Read any word subject indicate s/he does not know.

* Ensure that subjects follow steps on systematic self-instruction cue card.

* Ensure that partners follow cooperative efforts guidelines.

* At the end of each session for all groups, say: "You have done very well on the computer. Thank you for spending time on the program."

PROTOCOL FOR TRAINERS

Good morning/afternoon ______________(child's name)

You are going to work on the computer this morning.

Let me explain a few things first.

Have you used a mouse before?

If yes, go on to next line.
If no, show child how mouse works.

There are two monitors here.

The one on the left is a computer monitor.

The one on your right is a TV monitor. You will see pictures of real animals on this TV monitor as you work on the program.

Now, let's talk about the things you see on the computer screen.

FIRST SCREEN: **"Hi! I am Wise Lifty and I live in the jungle. I need your help little friend!"**

There are 2 buttons on the bottom of the screen. The lip button lets you hear the words on the screen. Try it.

The hand button pointing to the right allows you to go on to the next page. Are you ready to go on? Or do you want to hear the words again?

SECOND SCREEN: **" A new group of primates came into the jungle today. You have to tell me what kind they are, so I can send then to their friends."**

On this screen you see another hand button pointing to the left. You click it only if you want to go back to look at something again. Otherwise, use the right button to go on. Try doing it on your own for a while.

NEXT SCREEN: **"Primates are a group of warm-blooded animals that live all over the world..."**

Now, on this screen, you do not see any hand button to click on. What you have to do is to click on any red word on the screen. You will then see new information. Go ahead and pick a red word to click on.

MAP SCREEN: (world map - when hand button appears, tell child to click on hand button to go on)

NEXT SCREEN: **(On either Apes or Monkeys choices)**

On this screen, you do not see any hand button to click on yet. What you do is to click on any of the 4 choices here (point to 4 bars).

After you've seen each primate, there will be a check beside its name to let you know you've seen it. You may go back and look at anyone again.

Then after you've seen all four, the hand button will appear again to let you go on.

Do you have any questions? I will be sitting beside you and taking some notes. If you have any questions, just ask me, okay?

You may work on your own now.

APPENDIX G

SEA MAMMALS PROMPTING CARD

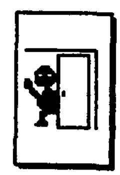
The Whale Family

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

where they live

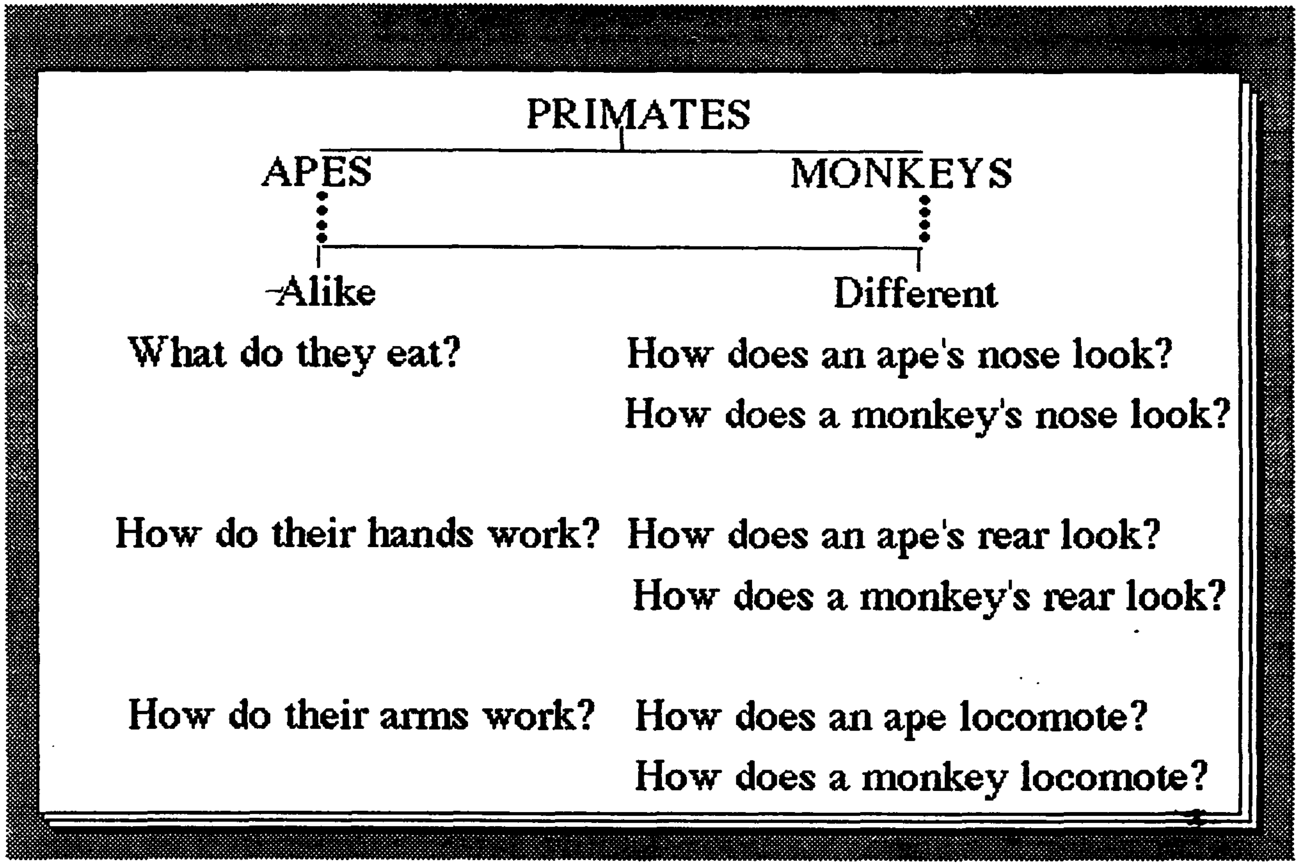
the largest

how they breathe



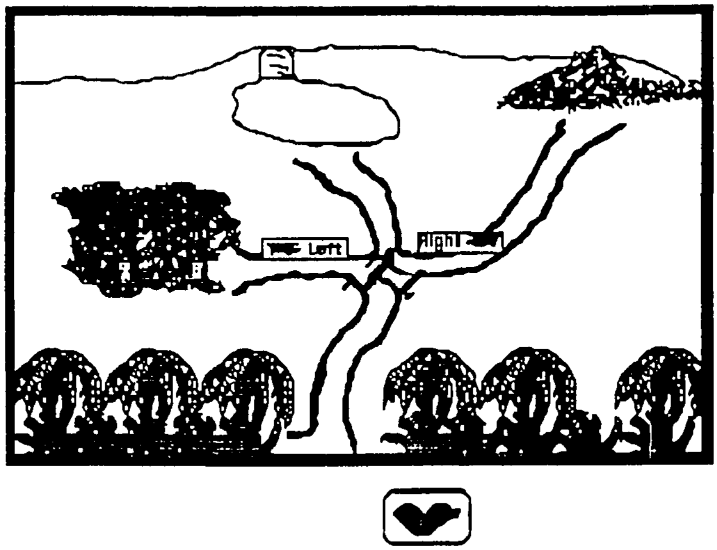
APPENDIX H

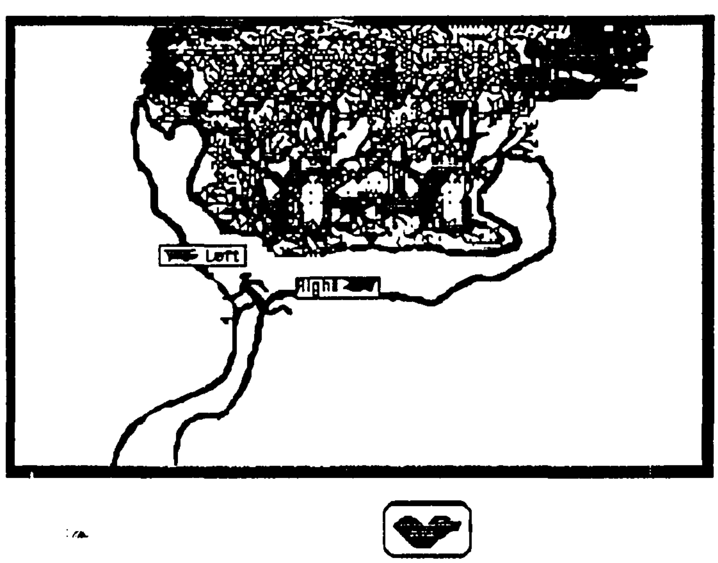
PRIMATES PROMPTING CARD


PRIMATES
APES
MONKEYS
Alike
Different
What do they eat?
How does an ape's nose look?
How does a monkey's nose look?
How do their hands work?
How does an ape's rear look?
How does a monkey's rear look?
How do their arms work?
How does an ape locomote?
How does a monkey locomote?

APPENDIX I

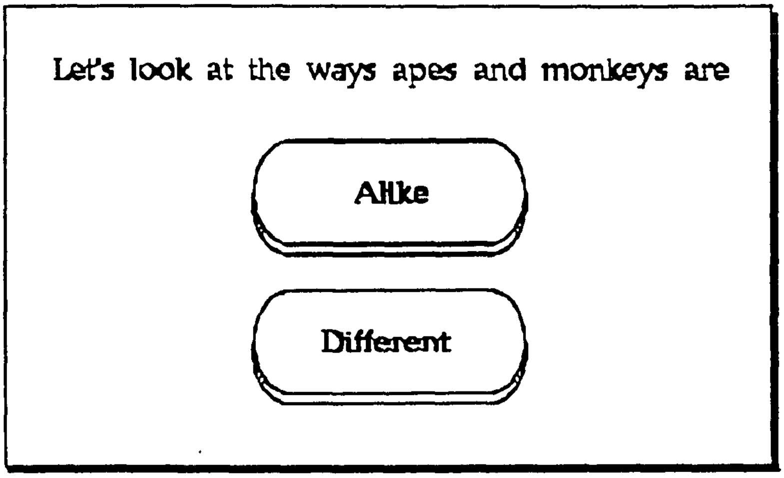
JUNGLE SCENE


Left
Right


Left
Right

APPENDIX J

PRIMATES-MENU FOR ALIKE AND DIFFERENT


Let's look at the ways apes and monkeys are
Alike
Different

APPENDIX K

PRIMATES-MENU FOR ALIKE

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

What they eat

How their hands and feet look and work

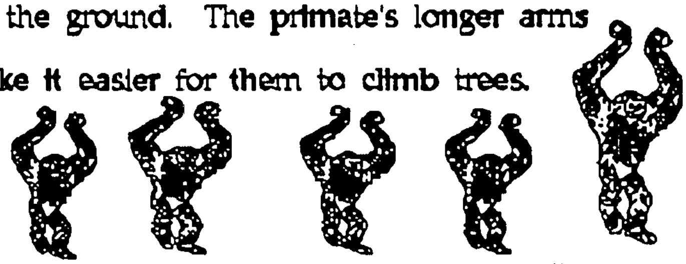
How their arms look and work

APPENDIX L

PRIMATES-INFORMATION FOR APE AND MONKEY ARMS

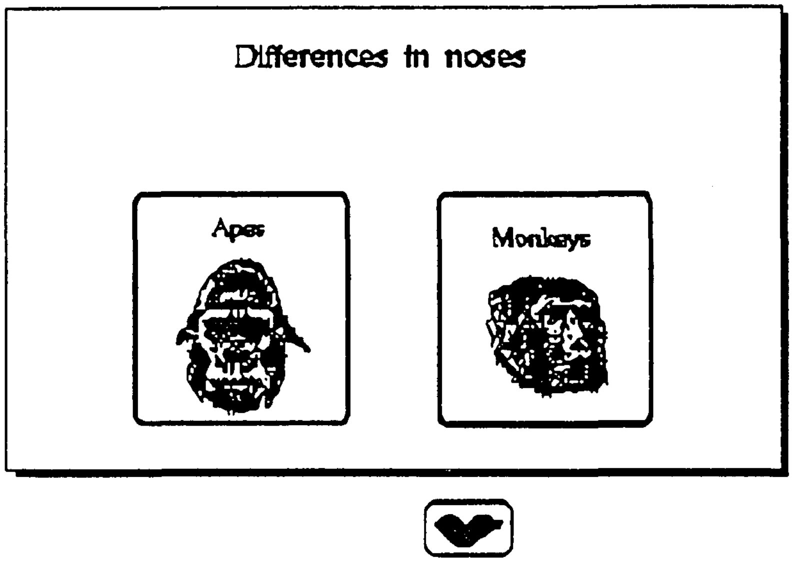
How arms are alike.

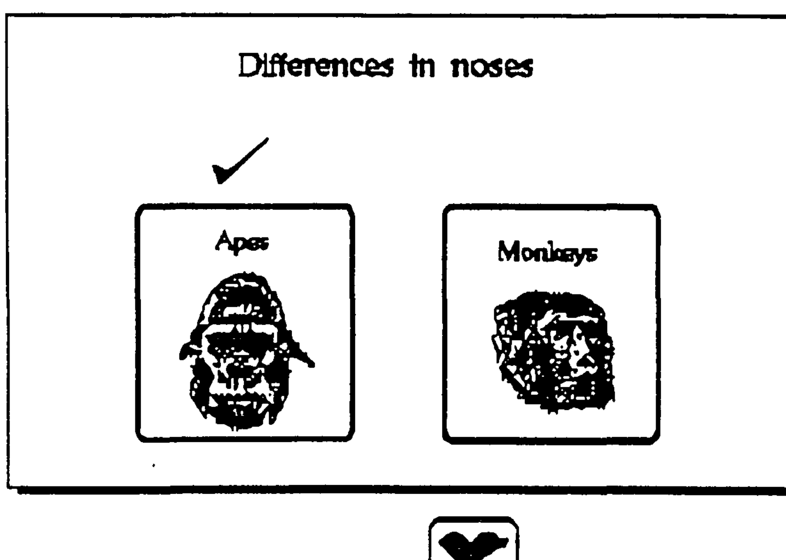
Ape and monkey bodies are just right for life in the trees and on the ground, too. They have longer arms than most animals that live on the ground. The primate's longer arms make it easier for them to climb trees.



APPENDIX M

PRIMATES-MENU FOR DIFFERENCES IN NOSES


Differences in noses
Apes
Monkeys


Differences in noses
Apes
Monkeys

APPENDIX N

PRIMATES-SUMMARY SCREENS

So you see, both apes and monkeys eat the same things, and use their arms, hands, and feet in similar ways.

What an adventure this has been for you! Now you see, by comparing and contrasting the primates, you helped me solve the problems.

APPENDIX O

PRIMATES-PROBLEM FOUR

Now look at these primates.

Find out which one is eating leaves.

Pygmy Marmoset

Chimpanzee

Red Uakari

APPENDIX P

PRIMATES-INCORRECT RESPONSE

Sorry! The chimpanzee is eating termites.

APPENDIX Q
PRIMATES-CORRECT RESPONSE

Good job! The Red Uakari is the primate eating leaves!