The Effect of Presentation Media on Student Reading Comprehension

Jeffrey T. Conklin
Western Michigan University
THE EFFECT OF PRESENTATION MEDIA ON STUDENT READING COMPREHENSION

by

Jeffrey T. Conklin

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THE EFFECT OF PRESENTATION MEDIA ON STUDENT
READING COMPREHENSION

Jeffrey T. Conklin, Ed.D.
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The purpose of this study was to investigate the effect of display media on
reading comprehension in students with learning disabilities. This research examined two
types of display media, computer screen and paper.

Three groups of subjects were used in this study: (1) readers with learning
disabilities, (2) low achieving readers, and (3) average readers. Three instruments were
used to gather performance data in this study: a) a standardized measure of reading
comprehension, b) a measure of individual passage comprehension, and c) a measure of
vocabulary knowledge using words from the experimental passages.

The data presented in this study supports the interpretation that presentation
media has no effect on the comprehension of reading material by readers with a learning
disability.
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CHAPTER I

INTRODUCTION AND BACKGROUND

The capabilities of computers used in education have improved greatly since the early introduction of computer-based-instruction (CBI) in the late 1950's. "CBI is defined as the use of a computer and/or associated technology with the intention of improving students' skills, knowledge, or academic performance" (Okolo, Bahr, & Rieth, 1993, p. 22). A great deal has been learned about appropriate and effective uses of CBI. As can be expected with any body of literature, research and findings for individual studies are limited to the technology available at the time of the research.

In the area of CBI, the limitation of the technology is an especially cogent variable since the capabilities of computers have changed so drastically over the past five decades. Much of what we have learned over the past five decades has been incorporated into the design of current technology-based-instruction. The previous conclusions of the historical body of CBI research have been assumed to be valid with the new platforms and instructional software of today. This early body of research may be obsolete, however, because of the advanced capacity of current computer platforms.

Rose, Meyers, & Pisha (1994), have remarked that the current trend in education to "include" more students with disabilities into the general education classroom will require the use of CBI to provide individualized instruction for these students. Waller
(1996) determined that computer display readability has not been examined as a variable in teaching reading to students with learning disabilities (LD). If this is the case, then additional research is required to determine if CBI is an appropriate medium for providing effective individual instruction to students with learning disabilities in reading. No research has surfaced that examines the effects of type of media presentation on the reading ability of students with learning disabilities.

Purpose of the Study

The purpose of this study was to examine the effects of the type of media used to present reading materials on reading comprehension in students with learning disabilities as compared to students with low reading achievement and average readers.

Background

The literature contains many studies on differences in reading comprehension between students with learning disabilities and their non disabled peers (Cawley & Parmar, 1995; Das, Mishra, & Kirby, 1994; Kletzien, 1991). The conclusion of these studies has been that learning disabled readers do not perform as well as low achieving readers and that different forms of intervention must be employed with students with learning disabilities than with low achieving students. There is a body of research that examines the use of CBI to enhance reading skills with L.D. and non-L.D. low achievers. In this research, CBI has been associated with improvements for both groups of readers,
however the achievement gains for the non-learning disabled readers tend to be greater than for students with learning disabilities (Higgins & Boone, 1990; Leong, 1995).

The Annual Report to Congress on the Implementation of the Individuals with Disabilities Education Act (1997) reported that 2.6 million students have been identified as having a learning disability (U.S. Department of Education Office of Special Education and Rehabilitative Services, 1997). This is an increase of 200% in the number of students identified with learning disabilities since 1987. The majority of these students (65%) are being educated in general education classrooms. With this large number of students with learning disabilities being educated in regular education classrooms, a need exists for effective and appropriate CBI.

The capabilities of computers have improved drastically over the past five decades. In the area of CBI this improvement is an especially cogent variable since previous limitations in computer capability may have a significant impact on current assumptions which are based upon previous research. For example: Blackhurst (1965) used an IBM mainframe, with teletyping input, in his research on motivation. Haus (1983) used a Tandy Model I with 4K memory in his research on math fact acquisition. Today's computers rarely have less than 32 MB of memory plus most are capable of high speed and high resolution graphics. Moore (1991) observed students and teachers using Zenith computers with 128K memory. These researchers and others (Cook, 1989; Fletcher-Flinn & Gravatt, 1995; Kulik, Bangert, & Williams, 1983; Okolo, Bahr, &
Rieth, 1993), questioned optimal learning paradigms as well as CBI design parameters within the limitations of the computer hardware and software available.

This body of research may be obsolete because of the advanced capacity of current computer platforms. Examples of the advanced capacity are the (a) Compaq Presario personal computer (PC) with 64 MB of memory, (b) Hewlett-Packard Pavilion PC with 128 MB of memory, and (c) e-machines PC with 32 MB of memory, all currently available at retail outlets for home computer users. The previous conclusions of the historical body of CBI research have been assumed to be valid with the new platforms and instructional software of today. Much of what has been learned over the past three decades has been incorporated into the design of current technology-based-instruction.

The literature contains many studies of the relationship between reading comprehension and typography. However, the majority of the research was conducted in the years prior to 1970 and the topic appears to have drawn little research interest until recently. The results of research into optimum print styles for the delivery of education, as well as other printed materials, have indicated that there are standards which should be used by the printing industry to create a reading product that is of most benefit to the reader (Ernst, 1977; Prince, 1952; Tinker, 1966).

Most of the research which has been conducted in typography and readability was conducted many years ago and was based upon text printed on paper. Some of the early research looked at letter and word design (Prince, 1952), letter construction (Gibson,
and writing system characters (Gillooly, 1971) and their effects on learning to read. Burt (1959) conducted research into the psychology of typography. Additional research examined readability of text and the recall of short passage prose (Miller & Kintsch, 1980).

An example of an important variable in reading text effectiveness is the use of specific print faces or fonts (Gillooly, 1971). The current research in CBI and typography has been scant and only two articles have been located that address the effect of print characteristics on reading comprehension. Venezky (1994) found that the readability of laptop computer displays for reading instruction was “not desirable” and Waller (1996) determined that computer display readability has not been examined as a variable in teaching reading to students with learning disabilities.

The results of typography research have noted that specific type styles, character size, word shape, case size, paper color, paper quality, and word spacing have a significant impact on the readability of materials, and on learning to read. However, some of the limits of these studies were that many of the print variables have an effect on each other and the interaction effect may lead to some confounding results (Waller, 1987).

The designers of CBI programs have not published research into the optimum type of program design or display. Often, a programmed text is simply a reduction of a textbook to a similar form displayed on a computer screen. Many of the articles which have been published in regard to CBI design have examined the attractiveness of the
display and the use of graphics to enhance screen displays. There have been a few studies which have looked at the improvement of reading achievement with non-disabled readers when graphics have been incorporated into CBI, as opposed to plain text on screen without enhancements.

While some of the literature has reviewed a limited number of these questions, many of these CBI studies did not look at the variables of typography and readability. They focused primarily on content and media, not design. Computer monitor text displays and printed text differ in image quality. Image quality has been described as "the physical measure of the image or the quality of the image as perceived or measured by a human observer" (Jorna & Snyder, 1991, p. 466). However, no physical measures of the image quality were taken in the previously-cited research.

The findings from comparison studies of monitor and printed text have been mixed, with some finding that reading from print-based text is faster (Gould, Alfaro, Finn, Haupt, & Minuto, 1987), while others have found that monitor displays were faster (Freese, 1997; Kamil & Intrator, 1998). It would appear that the visual image that is displayed on a monitor is dependent upon the level of technology that is within the particular computer system. There appears to be too many assumptions by the designers of educational software which are based upon obsolete or incomplete research on how the medium of presentation affects student reading performance. Additionally, this medium's effect may be entirely different with learning disabled students.
A number of investigators have conducted comparisons between printed text and monitor displayed text with conflicting results. Researchers examining the readability of computer generated displays have found that the presentation principles of paper color, paper quality, and white space, as cited in Tinker (1965), do not generalize from printed text to monitor presented text (Daniel & Reinking, 1987).

These accumulated results point to the need to conduct research into the effect of typography and CBI design with learning disabled students. It appears from an examination of previously studied research variables that the accumulated effect may be grossly measured using a single variable. This single variable in the research of reading comprehension may be the media used for text presentation: computer screen or paper.

Statement of the Problem

While historical research has examined some of these issues based upon obsolete computer platforms, additional data are required to examine the validity of current acceptance of previous findings. The void in the literature of any mention of the impact of current computer capabilities on reading comprehension in the population of students with learning disabilities in reading is readily apparent.

The purpose of this study was to investigate the effect of display media on reading comprehension in students with learning disabilities. Two areas of effect were examined: reading comprehension and vocabulary word recall. This study also examined any differential interactive effect between reading achievement and display
media by comparing the performance of students with learning disabilities with the performance of low and average achieving readers.
CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

The purpose of this review of the literature was to justify the investigation of the effect of presentation media on reading comprehension in students with learning disabilities. The review examined experimental research and theoretical literature from different perspectives and disciplines which include special education, computer technology, media research, reading, and educational psychology.

Computer-based teaching programs have come a long way since they were first introduced (Kulik, Bangert, & Williams, 1983). Much of the research on the effectiveness of computer-based instruction occurred over the past 20 years. During this time, many have used a traditional model of using accumulated findings to support and develop the knowledge base. Unfortunately, this traditional model may not be valid.

A review of the literature in this area has pointed to four general areas that need to be explored: (1) Computer-based instruction and computer platform performance, (2) The difference in reading achievement between readers with specific learning disabilities in reading and low readers, (3) The effect of typography on reading
comprehension, and (4) The lack of research into the effect of presentation media on CBI design.

Rise in the Use of Computer-based Instruction in Education

"CBI is defined as the use of a computer and/or associated technology with the intention of improving students' skills, knowledge, or academic performance" (Okolo, Bahr, & Rieth, 1993, p. 22). Many of the authors of early Computer-based Instruction (Gerard, 1967) programs believed that they would bring great benefits to students and teachers. Some of the expected benefits were self-paced instruction for students which would result in faster learning, the availability of richer and more sophisticated materials, expert-system-based instruction, and dynamic assessment (Zeaman, 1962). The benefits for teachers were expected to be the ease of modifying instructional materials and better time management, which would result in their having more time to assist individual learners who required additional contact (Okola, Bahr, & Rieth, 1993).

CBI's effectiveness with both general education and special education students has been examined by many researchers. In general, reported results were that it is at least as effective, if not more effective, than traditional methods of instruction. Research has focused on learning components of CBI, such as math fact acquisition (Haus, 1983), writing enhancement (Peterson, 1993), problem solving strategy acquisition (Lieber & Semmel, 1987), science simulation (Sherwood & Hasselbring, 1986), process skills such as time-on-task (Moore, 1991), and motivation (Blackhurst, 1965). A major
component of CBI which has not been addressed, that very well may preclude our acceptance and generalization of historic research findings, is the computer itself.

**Improvements in Computer Systems**

Over the past two decades the media for presentation and control of CBI content have dramatically changed. When Skinner (1958) and Blackhurst (1965) conducted their original work on effectiveness of CBI, the computer used by both of them was an IBM 360/40 with a teletype interface; Haus (1983) used a Radio Shack Model I with 16K of memory; Moore (1991) observed students and teachers using Zenith computers with 128K of memory.

Today's computers have thousands of times the capability of the computers upon which our historic knowledge base is established. With the added capability of computers, many potentially confounding variables need to be questioned. Are we using outdated findings to continue potentially inappropriate practices with the newer equipment and software which is now available? Are we able to replicate the finding of others by simply upgrading the CBI system to the latest platform or are the basic historical findings not generalizable? The generalizability of historical findings to present research and applications becomes questionable.

Many of the decisions made by educators in regard to CBI have been based upon the assumption that findings reported by researchers using older platforms are transferable and generalizable to all platforms and systems. The work of Lieber and
Semmel (1987) on math instruction was based upon an Apple computer and a computer program written in Basic. The findings of this research have been used to support the research reported by Horton & Lovitt (1994) when using a microcomputer with 1000 times the capacity. Others (Fletcher-Flinn, & Gravatt, 1995; Okolo, Bahr, & Rieth, 1993) have shown that they have used findings based upon using an obsolete platform and simple software to pursue further investigations into software effectiveness.

If the basic historical data which are used to base CBI decisions are not applicable to current research, then we are operating under several false assumptions: all previous findings, no matter what capabilities the computer possessed, are generalizable; the type of platform used for CBI is interchangeable with other platforms; and, all new research on CBI based on current platforms and systems is a continuation of work previously conducted by others and is valid.

A review of the literature yields little questioning of the generalizability of historical findings of CBI to current research practices and classroom use. Most of the previous findings appear to be accepted as a given base of knowledge and other research simply begins at that point in CBI development. This can lead us to the assumption that we do not have to investigate previously-conducted research with more current platforms and systems.

**Types of Computer-based Instructional Programs**

Educational software has greatly improved since the early 80's. There are many
excellent educational programs on the market (Maddox, Johnson, & Willis, 1992). The current question of software quality has been expanded to include the issues of software usefulness or appropriateness. There are four major categories of CBI software: 1) drill and practice, 2) tutorial, 3) simulations, and 4) problem solving (Fletcher, Flynn, & Gravatt, 1995; Liao, 1992).

In the design of most CBI, authors assume learning strategies derived from a range of learning theorists from behaviorists to Vygotsky and neo-Piagetians (Maddox, et al., 1992). Haus (1983), in his work, determined that a theoretical base exists for the construction of CBI, which is often used by the programmer for the design of the program, but it is largely ignored by the designers of the instructional content. The theoretical paradigm that provides the basic format for the design of CBI is found in the principles of programmed instruction. Programmed instruction has its foundations in operant conditioning with its stimulus and response format. Haus found that, contrary to the recommendations of other authors as to what components should be included in CBI, no empirical research existed that tested these components as independent variables. To date, no further research has been conducted.

It was expected that CBI would show more of a learning advantage over time as both computers and programs became more sophisticated (Hannafor, 1993). Few meta-analytic reviews have been conducted since the advent of new hardware and software that create a multimodal and exploratory learning environment with the use of hypertext and hypermedia. The lack of research publications for this medium probably reflects the
relative infancy of such technology and the high cost of such materials at the present 
(Fletcher-Flinn, & Gravatt, 1995).

Evaluation of new computer technology will present new challenges to the 
researcher and it is hoped that mistakes in the past resulting from poorly designed studies 
are not repeated.

**Types of Computer Platforms**

The two most popular computer platforms used in this country are Macintosh 
and MSDOS/Windows. However, the differences in hardware, software, and availability 
of features between the two have diminished, as well as the differences in their ease of 
use (Willis, 1993). Liao (1992), in a meta-analysis, compared student cognitive outcomes 
using CAI and determined that there was a moderate positive increase in student 
cognitive outcomes in studies using mainframe/minicomputers compared with studies 
using microcomputers. Mainframe/microcomputers were described as having the 
capability to perform multiple calculations, have many complex input/output devices, 
and simultaneously service a great number of connected users from remote locations, all 
at one time. Microcomputers were defined as a desktop or personal computer which had 
the capacity of serving a single user (Steinhoff & Lyon, 1993). No significant difference 
was found in the means between studies identified as microcomputer and unspecified. 
Also there was no significant difference on the mean comparison between studies coded
as mainframe/minicomputers and unspecified. These findings may have been precipitated by the relative differences in capabilities of these two computer types.

An interesting aspect of a review by Niemiec and Walbur (1987) was the reported advantage in effect size of microcomputers over mainframe-based studies. In a meta-analysis conducted by Fletcher-Flinn, & Gravatt, (1995) it was expected that there would be a significant increase in the effect of CAI on student learning over time due to the production of more powerful and efficient computer hardware and software, but the estimates of effect size remained fairly stable from 1989-1992.

Students with Learning Disabilities and General Education Students

Learning disabilities, first recognized in the 1960's (Kirk & Weiner, 1963), refers to a heterogeneous group of learners with the common feature being that they have unexpected trouble learning in school. The federal government (Individuals with Disabilities Education Act Amendments, 1997) defines learning disabilities as:

a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, read, write, or do mathematical calculations. The term includes such conditions as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia and developmental aphasia.

The term does not include children who have learning problems which are primarily the result of visual, hearing, or motor handicaps, of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage.
Students with a learning disability in reading are often characterized as having a problem decoding words, recognizing words, or with comprehension of written text (Lerner, 1997). There are, however, many ways to define and describe reading-related learning disabilities. Fletcher (1992) wrote about the differences and similarities of reading disability and dyslexia. An often-used method to classify students with learning disabilities is through the use of the "discrepancy model" (Salvia & Ysseldyke, 1995). This is determined by the discrepancy between IQ scores and reading performance data. The examiner searches for a discrepancy between the potential of the student and the actual performance that the student can achieve (Reynolds, 1985).

Research has suggested that learning disabilities can be reliably identified (McLeskey & Waldron, 1990) and reliably distinguished from other characterizations, such as low achievement (Kavale, Fuchs, & Scruggs, 1994). In a number of studies cited by Mastropiera, Scruggs, Bakken, and Whedon (1996), students with learning disabilities were characterized as having a mean IQ of 94 and averaged at least 2 to 3 years below grade level in their performance. In their meta-analysis, they found that researchers employed a variety of reading comprehension measures: story retelling, free recall, multiple-choice comprehension questions, vocabulary word recall, maze and cloze procedures, paraphrasing, error detecting, inferential explanation, and standardized tests of reading comprehension to measure reading performance. Two of the most often used methods to determine reading performance are multiple-choice comprehension questions

There have been comparisons made between students with a learning disability and their general education peers in regard to reading achievement as a measure of the reading process. To explain the reading process it is important to understand three distinct elements of reading: (1) comprehension, (2) retention, and (3) fluency (Lyon, 1994). Reading comprehension has been defined as a process of constructing meaning from written text, based on a “complex coordination of a number of interrelated sources” of information (Anderson, Hiebert, Scott, & Wilkinson, 1985). As such, reading comprehension is, arguably, the most important academic skill learned at school. Students with learning disabilities typically exhibit substantial deficits in reading comprehension, which may include not remembering the gist, facts, and details of text material; they also have more problems in interpreting and making inferences about the information presented (Mercer & Mercer, 1993).

Retention is described as the ability to recall information from previously learned material at a later time (Torgeson, 1994). Children with learning disabilities in reading often exhibit problems with retaining information from the material they have read. This is considered to be an information storage and retrieval problem where information is not readily available in memory when the student is required to recall it (Lerner, 1997).

Fluency is described as reading quickly and smoothly. It is highly dependent on the reader's ability to recognize words quickly and easily. It is also a result of the
reader's ability to process words automatically without having to consciously decipher them (Lerner, 1997). Fluency building and vocabulary acquisition are necessary components of reading comprehension (Mastropieri & Scruggs, 1997). Students with L.D. are often characterized as dysfluent readers (Hallahan, Kauffman, & Lloyd, 1996).

A large amount of work has been undertaken to clarify and define learning disabilities and their impact on reading achievement. The resulting characterizations clearly show the empirical difference between the two groups. Students with a specific learning disability in reading have reading achievement scores that are consistently low, often as much as three to five years behind their actual grade placement (Zigmond & Baker, 1990). However, general education students have reading achievement scores that range within expected limits for their grade level. Any test that requires reading should discriminate between children with a reading learning disability and non disabled readers (Das, Mishra, & Kirby, 1997).

Reading Related CBI for Students with Learning Disabilities

There has been a vast amount of research conducted on the achievement differences of "normal" students who have had CBI versus a peer group using traditional instructional methods. These results have been inconsistent or non-significant for the most part. Fletcher-Flinn and Gravatt (1995) reported results which indicated greater improvement in reading achievement scores for the lowest performing students,
moderate gains for the moderately achieving students, and a minimal gain for the highest functioning students when using CBI.

Matthews (1997) examined the relationship between reading comprehension of general education students using “Living” storybooks presented on a computer versus traditional printed text storybooks. There were no statistical differences in reading comprehension levels with either group and the organization of the material was not dependent on the format used for the presentation.

Recently, several researchers have reported on the use of computers to aid students with LD in language arts (Dalton, Winbury, & Morocco, 1990; MacArthur, Graham, Haynes, & DeLaPaz, 1996; McNaughton, Hughes, & Ofiesh, 1997). They reported that technology, while of some benefit, was not sufficient to remediate the difference in performance scores between students with a learning disability and their non-disabled peers.

Use of CBI for Individualized Instruction

Given the characteristics of students with LD and the legal mandate to include more students with special needs in the general education classroom it is important to comply with the legal requirement to individualize instruction for students with special education needs. With this mandate in mind, as well as the insufficient financial resources to hire additional teachers to provide individualized instruction, it is important to look to methods other than additional teacher-time. The reported ability of current
computer platforms to provide supplemental instruction for students may be one of the methods that can be employed to individualize instruction for students with special needs. Careful research into the effect of computer presentation of reading materials on reading comprehension for students with learning disabilities is critical to the resolution of the issue of whether computers can be used in this process of individualization of instruction. While historical research has examined some of these issues based upon obsolete computer platforms, additional data are required to examine the validity of accepting previous findings. The void in the literature of any mention of the impact of current computer capabilities on reading comprehension in the population of students with learning disabilities is readily apparent.

If the use of CBI is to provide individualization for students in order to comply with inclusionist philosophies, as explained by Rose, Meyer, and Pisha (1994), we need to determine that CBI and its method of instruction does not present additional problems for the learner.

Typography and Reading Comprehension

There is extensive research in the history of typography and graphology for printed text. Many of the researchers examined the relationship between typography and reading comprehension. The components which have been examined are: size of character, font, thickness of stroke, white space between strokes, dissimilarity of characters, leading (amount of space before a line), line length, frequency of kerns.
(irregular letter spacing), similarity of figures, width of figures, quality of paper, color of paper, light reflectance of paper, color of ink, illumination, and irradiation (Waller, 1996). The results of this body of research are described in the many manuals which are used to determine what typography is used with specific methods of presentation and for what audience, when developing written text (Buckingham, 1931; Den Buurman, Roersema, & Gerrissen, 1981; Raban, 1982; Spencer, 1969).

There has been little research into the characteristics of computer generated text and its effect on reading comprehension. Bouma (1980) examined visual reading processes and the quality of text displays on computer terminals, however this study was based upon a mainframe computer which is obsolete in today's educational environment. In 1980, computer text was generated by 8 x 6 pixels with constant spacing, 10 characters per inch; in 2000, computer text is generated by 120 pixels per inch and SVGA screens use 1024 pixels per inch. Venezky (1994) questioned the screen resolution of laptop computers and its effects on readability. He also stated that "the intelligent reading of hypertext involves not only the ability to interpret text and graphics but substantial navigational ability as well" (p.57). Barnett and Seefeldt (1989) determined that the nonlinear reading comprehension strategies of rereading and "lookbacks" increased reading comprehension and retention. CBI, however, uses a linear display. Textbooks are considered to be nonlinear because the reader is able to jump around backward or forward and does not have to read the pages in order (Sherwood & Hasselbring, 1986). The basic design of most CBI programs is linear in nature because
the designers of the programs followed the controlled operant learning paradigm as described by Zeaman (1959). In this paradigm, material is presented in a fixed order with small steps, which are followed one at a time. This presentation method does not readily lend itself to nonlinear reading comprehension strategies due to its inherent design features however, current CBI no longer can be considered nonlinear given the advent of hypertext and other related features.

Text Presentation and Reading Comprehension

There have been several studies conducted where different media were used for the presentation of instructional materials (Casteel, 1988-1989; Higgins & Boone; 1990; Leong, 1995) but the effects of the media were not examined and were not the primary focus of the study since it refers to more than one. This would support the notion that additional research should be conducted to examine the relationship between presentation type and reading comprehension.

The Need to Assess Reading Comprehension on Computers

Studies by Casteel (1988-1989), Helfeldt and Henk (1985), Manzo (1985), and Standish (1992) found no statistically significant differences in students’ comprehension when comparing students who read electronic texts with students who read traditional printed text. However, Matthew (1997) found that student comprehension of electronic text was greater than comprehension from printed text.
Russell (1999) and Russell and Henry (1997) examined student performance on writing assessment instruments that used computer based versus paper-and-pencil presentation formats. They found that general education students in middle school performed “substantially” better on open ended writing assessments if they had prior experience with computers. However, they found no difference in performance on multiple-choice instruments regardless of mode of administration. Their studies examined the performance of general education students and they pointed out that their subject population did not include students with learning disabilities.

Beck, McKeown, Sinatra, and Loxterman (1991) and Neal (1991) both examined the impact of computer-based assessment on student test performance. They found that for the general education population the method of presentation did not affect performance outcomes. The methods used in both of their studies used two independent measures of reading performance: (1) reading comprehension, and (2) vocabulary word-meaning recall. Both of their studies lacked the inclusion of individuals with learning disabilities.

Summary

The purpose of this review of the literature was to justify the investigation of the effect of presentation media on reading comprehension in students with learning disabilities. The review examined experimental research and theoretical literature from different perspectives and disciplines which include special education, computer
technology, media research, reading, and educational psychology. Several conclusions have been supported by this review:

1. Students who have learning disabilities in reading do not perform as well as students without disabilities in reading comprehension.

2. The use of computers in education has increased greatly over the past twenty years.

3. Students who have learning disabilities do not appear to have larger educational gains through the use of CBI than general education students.

4. The use of CBI for individualized instruction for students with learning disabilities is being promoted with outdated research-based data to support its use.

5. No research exists that examines text presentation media on reading comprehension in students with learning disabilities.
CHAPTER III

METHODOLOGY

Introduction

The purpose of this chapter is to present the overall procedures and methods which were used in this study, with supportive rationale when appropriate. Discussion includes: (a) a description of the research population, (b) a description of the research design, (c) data collection procedures, and (d) a description of the study questions, research hypotheses, and data analysis methods.

Subjects

The subjects used in this study were drawn from a middle school in southwestern Georgia which was randomly selected from the three middle schools in the Dougherty County Public Schools, located in Albany, Georgia, a city with a population of 80,000. The initial subject pool consisted of 438 sixth-, seventh-, and eighth-grade middle school students. The Dougherty County Public School system, is a medium-sized public school district which serves 15,000 students, predominantly African-American. Students are assigned to a teacher and a "home-room" but move hourly among several teachers and classrooms. The research data were collected in the 1999-2000 school year. All subjects
had one hour per day exposure to computers in the school's computer laboratories and several professed possession of computers in their homes. Each middle school in the district has several computer labs which are equipped with Windows-based computer platforms. Each lab has a classroom teacher to monitor student progress. Computer instruction in the labs is subject oriented and the computing teacher instructs the students in computer and software program use. All subjects in the initial pool were administered the Iowa Test of Basic Skills (ITBS) by the school district in March of 1999. The scores from the reading portion of the ITBS are reported as grade equivalent scores in the student's cumulative record. The initial pool of subjects was divided into three groups based upon their education classification in the school: (1) readers with learning disabilities, (2) low readers, and (3) average readers. Students with L. D. are students who have been classified by the local school district as being eligible for special education services under the State of Georgia Special Education Law definition for students with a specific learning disability in reading. This state definition requires a severe discrepancy between ability and achievement, when an achievement score is 1.34 or more standard deviation units lower than the cognitive ability score (State of Georgia, 1999). These students also demonstrate a discrepancy between their Iowa Test of Basic Skills (ITBS) grade equivalent scores and their actual grade placement of -2 or greater standard deviation units. Students with a specific learning disability are expected to score average or above on a standardized test of intelligence.
Low readers are defined as students who have been identified by the local school system as being eligible for special reading services under the provisions of Part A, Chapter 1 of Title I, Improving America’s Schools Act (1994) but are ineligible for special education services under the State of Georgia Special Education Law definition for a specific learning disability in reading. These students also demonstrate a discrepancy between their ITBS grade equivalent scores and their actual grade placement of -1 to -2 standard deviation units.

"Average readers" are students who are ineligible for services under either the State of Georgia Special Education Law definition or the local school district’s eligibility requirements for Title I, Part A assistance due to their grade level reading performance and who demonstrate a discrepancy between their ITBS scores and their actual grade placement of -1 to +4 standard deviation units.

Ninety students, thirty in each group, were randomly selected from the 438 students and permission slips were sent home with them. Thirty-six students, 12 in each group, were randomly selected from the pool of 46 students who returned permission forms. The demographic characteristics for the subject groups are shown in Table 1. For purposes of validating the groups, three lists were generated that designated readers with learning disabilities, low readers, and average readers. These lists were circulated among the reading instruction teachers for the students on the lists. The selection criteria for the three groups were included with the lists. The teachers were asked to determine, on the basis of their observations of their students’ performance, if any of the students...
Table 1
Demographic Characteristics of the Subject Population

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Age</th>
<th>Race</th>
<th>Sex</th>
<th>Grade</th>
<th>ITBS Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>AA</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>Readers with L.D.</td>
<td>12</td>
<td>13.4</td>
<td>1.25</td>
<td>10</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Low Readers</td>
<td>12</td>
<td>13.6</td>
<td>.79</td>
<td>11</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Average Readers</td>
<td>12</td>
<td>13.6</td>
<td>.62</td>
<td>12</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
were inappropriately grouped. The teachers reported that the students were listed in the proper groups.

Equipment

Hardware

Four Texas Instruments, Extensa 570CD laptop computers with 64MB of Random Access Memory (RAM), were set up in an empty classroom, and used to present treatment conditions. A Microsoft Operating System that comes standard with Windows 95 was loaded on the computers. Each computer was equipped with a 3 ½ inch High Density (HD) floppy drive and displayed material on an 11 inch Liquid Crystal Display (LCD) color monitor panel which was configured by the computer operating system to use a standard video display monitor driver included with the computer operating system. The resolution of the monitor display was 800 x 600 pixels.

All text presented either on the computer screen or printed on paper, both upper and lower case, was printed using the Times New Roman font, kerned, with a size of 12 points. The left margin was justified but the right margin was not. Letters appeared black upon a white background. All monitors were attached to the computer processing units and were placed at a distance of approximately 18 inches from the subject. Controls for brightness, contrast, and alignment of the monitor display were preset by the
experimenter at the default levels which were present on the computers. The monitor controls were not accessible to the subjects, so that no subject tampering could occur.

**Software**

The computer generated text display was created using Microsoft PowerPoint, version 7.0. The PowerPoint program was operated as a stand-alone presentation from a 3 ½ inch, double sided, high density, formatted floppy. The disks were formatted to operate on an IBM compatible system and had a capacity of 1.44 megabytes of data.

**Instrumentation**

Three instruments were used to gather performance data in this study: a) a standardized measure of reading comprehension, b) a measure of individual passage comprehension used in previous studies, and c) a measure of vocabulary knowledge using words from the experimental passages also used in previous studies. The reliability and validity of these instruments will be discussed below.

**Iowa Test of Basic Skills**

Grade equivalent scores of the *Iowa Test of Basic Skills, Levels 9-14, Form M*, (Hoover, Hieronymous, Frisbie, & Dunbar, 1996) were used to identify readers with learning disabilities, low readers, and average readers for this study. The grade equivalent score was calculated by combining the vocabulary and the comprehension
subtests of the ITBS. All subjects in the original subject pool were administered these subtests in classroom groups. Tests were administered in accordance with the standard test administration procedures as specified in the administration manual which accompanies the testing materials. Items in the vocabulary subtest require the students to select the correct word from the four written in their test booklets which best completes a sentence read to them. The comprehension subtest requires the student to silently read short reading passages and answer several multiple-choice questions which are related to each passage.

**Comprehension Measures**

As per Reinking (1983), Beck, et al. (1991), and Brophy (1996), two types of comprehension measures were used in this study: a six item multiple-choice test which subjects responded to after each of the six experimental passages (cumulatively 36 items, see Appendix A for passage questions) and a 30 item multiple-choice vocabulary test (see Appendix B) constructed using words from the six reading passages. A discussion of the reliability and validity of these two instruments is included below.

**Validity**

Validity is dependent upon how accurately a specific content area has been sampled (Hinkle, Wiersma, & Jurs, 1994) and is a property of the inferences drawn from the sampling instrument (Salvia & Ysseldyke, 1998). With this definition in mind, the
content area sampled in the multiple-choice comprehension and the vocabulary instrument was from the six reading passages used in this study and the words selected from those passages for definition in the experimental treatments. These two tests were used to make inferences about variances in treatment conditions in the comprehension of reading passage content and the recall of word meanings from these experimental passages. The content validity of the two measures should be considered supported due to the relatively small domain sampled and the large number of sampled items from each passage. The face validity of the instruments is supported because the multiple-choice format used in both instruments has been recognized as an acceptable method for making comparisons of reading comprehension and vocabulary knowledge (Nunnaly, 1976).

Reinking (1983) developed these test items specifically to strengthen claims of validity and reliability. More items were developed by Reinking than were required for the comprehension test. All of the questions were piloted with a sample (n=33) of fifth- and sixth-grade readers who scored between the 50th and 75th percentile on a standardized test. All of the students in the pilot study read the passages and answered all the questions from the item pool. Any item not having a point biserial correlation to total test scores of at least .25 and/or having more than a .90 probability of being answered correctly was not used.

In an attempt to eliminate the possibility that the subjects in the experimental group could answer the multiple-choice questions correctly without reading the passages the items were tested for passage dependency by Reinking. Another sample was selected
and the subjects were asked to answer the questions to the best of their ability without reading the passages. Any item answered correctly by more than half of the test group was eliminated.

Test items were also constructed using the guidelines suggested by Pearson and Johnson (1972). All responses were written to require textually explicit information and were written as complete sentences (Reinking, 1983). Correct responses were often a paraphrase of material contained within the passage text so that they were a test of comprehension rather than recall (Anderson, 1972).

Reliability

The reliability of an instrument refers to the generalizability of the data from a particular set of observations and is highly correlated to validity (Salvia & Ysseldyke, 1998). The interactive effect of reliability of any measurement instrument on the validity of the instrument is robust (Hinkle, Wiersma, & Jurs, 1994). Previous research (Reinking, 1983) made use of these experimenter-designed instruments and reliability studies were documented in this work. For the current study, this author conducted additional reliability tests on the instruments to provide support for their use in this specific study. As can be seen in Table 2, the Spearman-Brown Formula yielded a split-half correlation of .79 and .78 respectively for the cumulative scores on the passage questions and the vocabulary test. The Guttman formula was also used to establish the reliability of the tests used in this experiment with a result of .79 on the passage
questions and .77 on the vocabulary items. This was performed because the homogeneity of the items in the reading comprehension instrument is an important consideration due to the calculated comprehension score being based on comprehension questions from the different passages, which varied in difficulty. These data support those found by Reinking.

Table 2
Recalculated Reliability Coefficients for Test Instruments

<table>
<thead>
<tr>
<th>Test</th>
<th>No. of Items</th>
<th>r*</th>
<th>r**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading Comprehension</td>
<td>36</td>
<td>.79</td>
<td>.79</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>30</td>
<td>.78</td>
<td>.77</td>
</tr>
</tbody>
</table>

* split-half estimate based upon scores correlated by the Spearman-Brown Formula
** Guttman split-half formula

The formula calculated values of .79 for the comprehension test and .77 for the vocabulary test. These reported values are considered to be acceptable for the reliability of the instruments used in this experiment (Kubiszyn & Borich, 2000).

Items were constructed to comply with several restrictions. Multiple-choice questions which require the completion of sentences may involve the reader's short-term memory, so questions were constructed using complete sentences. It was important to construct test items which were based upon the information contained within the text
passages. Correct responses were often a paraphrase of the material contained within the text passage to provide a more valid test of reading comprehension rather than passage recall. Incorrect response items were composed of material similar to the text material but not contained within the text, a keyword or phrase from the passage which was unrelated to the item, and a response that was incorrect based upon the information in the passage. To demonstrate the application of the restrictions, an example of a comprehension instrument item and the reading passage it was selected from are outlined below:

**Passage.** Another chemical process washes away the grains not touched by light, and at the same time fixes the disturbed or exposed grains.

**Instrument item.** What happens to the silver grains not touched by light?
1. They are left on the film.
2. They are washed away by chemicals.
3. They are fixed by the chemicals.
4. They turn black on the negative.
   (Correct response is 2.)

The vocabulary instrument was constructed by Reinking (1983) to increase its reliability and validity using the following procedures: The subjects were instructed to select a word which was the most similar in meaning to the word in the reading passage. This instruction required the subject to make a selection for a definition of a word which was consistent with the passage’s contextual use of the word. The distractors often included words which were used in the passage but were not similar in meaning to the vocabulary word. Alternate definitions of the targeted vocabulary word were also
offered as selections, however these alternative words were not used in any of the experimental passage selections. The vocabulary instrument is provided in Appendix B.

Materials

Passages

The six passages used in this study were adapted from the Science Research Associates (SRA) Reading Mastery Series (Parker, 1963) which were used previously by Reinking (1983). The SRA passages were selected for the following reasons:

1. The previously cited studies were conducted to determine the effect of computer-mediated text on reading comprehension but the subjects selected for study were students who had reading levels at or above grade level and were not considered to have specific learning disabilities or reading skill deficits. In order to replicate the previous study with different subjects the same instrumentation needed to be used.

2. The SRA reading passages are short and could be displayed in entirety on one printed page or on one computer screen.

3. The difficulty level of the passages could be calculated.

The six experimental reading passages are displayed in Appendix C. The readability of the six passages was calculated using the Microsoft Word software program using the Flesch-Kincaid Readability Formula and the Flesch Reading Ease Formula (see Table 3). The passages have been classified into two difficulty levels; easy
and hard. The mean readability estimate for the easy passages is at a grade level of 3.4 years and the hard passages is 8.9 years.

Table 3
Passage Characteristics and Readability Estimates

<table>
<thead>
<tr>
<th>Passage</th>
<th>Difficulty</th>
<th>Words</th>
<th>Sentences</th>
<th>Flesch Reading Ease</th>
<th>Flesch-Kincaid Grade Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passage 1 (Hail)</td>
<td>Easy</td>
<td>124</td>
<td>13</td>
<td>95.3</td>
<td>2.2</td>
</tr>
<tr>
<td>Passage 2 (Mercury)</td>
<td>Easy</td>
<td>150</td>
<td>12</td>
<td>78.8</td>
<td>5.3</td>
</tr>
<tr>
<td>Passage 3 (Lake)</td>
<td>Hard</td>
<td>162</td>
<td>8</td>
<td>67.0</td>
<td>8.8</td>
</tr>
<tr>
<td>Passage 4 (Pots)</td>
<td>Hard</td>
<td>152</td>
<td>6</td>
<td>60.4</td>
<td>10.1</td>
</tr>
<tr>
<td>Passage 5 (Film)</td>
<td>Hard</td>
<td>149</td>
<td>9</td>
<td>67.6</td>
<td>7.8</td>
</tr>
<tr>
<td>Passage 6 (Salt)</td>
<td>Easy</td>
<td>123</td>
<td>12</td>
<td>93.1</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Procedures

The experimental protocol for this study was reviewed and approved in the category of Exempt by the Human Subjects Institutional Review Board (HSIRB) of
Western Michigan University. All subject recruiting, selection, permission, and testing was performed under approved HSIRB procedures. The approval documentation is contained in Appendix D.

The subjects in the study were assigned to one of three reading achievement groups and attended training meetings conducted by the researcher to inform them of the nature of the study and that their participation was strictly voluntary. The subjects also were told that their participation and performance in the study would have no impact on their grades and could be terminated by them at any time during or after the study. They were also informed that any data generated by the study would be kept confidential and would not be released to any other persons.

The subjects received training at the time of the testing situation on how to use the computer keyboard's left mouse button to select the reading passage and how to proceed to the next reading passages by depressing the mouse button. The training instructions are contained in Appendix E.

Students were informed that the testing was scheduled for administration in an assigned classroom and would take approximately one hour of their time.

Treatment Conditions

The subjects were administered three reading passages on line, on the computer screen, and three reading passages off-line, as printed text. The order of presentation and the determination of which passage was displayed on which type of media was randomly
assigned within each individual, using random numbers generated by a computer (see Table 4). The differences among the treatment conditions are specified below.

Table 4

<table>
<thead>
<tr>
<th>Media and Order of Passage Presentation by Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
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</tr>
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<td>12</td>
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<tr>
<td>13</td>
</tr>
<tr>
<td>14</td>
</tr>
</tbody>
</table>
Table 4-Continued

<table>
<thead>
<tr>
<th></th>
<th>P3</th>
<th>P1</th>
<th>P6</th>
<th>C2</th>
<th>C5</th>
<th>C4</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>C5</td>
<td>C4</td>
<td>C3</td>
<td>P6</td>
<td>P1</td>
<td>P2</td>
</tr>
<tr>
<td>17</td>
<td>P5</td>
<td>P6</td>
<td>P3</td>
<td>C4</td>
<td>C1</td>
<td>C2</td>
</tr>
<tr>
<td>18</td>
<td>C4</td>
<td>C6</td>
<td>C5</td>
<td>P1</td>
<td>P2</td>
<td>P3</td>
</tr>
<tr>
<td>19</td>
<td>P3</td>
<td>P5</td>
<td>P6</td>
<td>C2</td>
<td>C1</td>
<td>C4</td>
</tr>
<tr>
<td>20</td>
<td>C6</td>
<td>C5</td>
<td>C1</td>
<td>P2</td>
<td>P3</td>
<td>P4</td>
</tr>
<tr>
<td>21</td>
<td>C2</td>
<td>C3</td>
<td>C6</td>
<td>P5</td>
<td>P4</td>
<td>P1</td>
</tr>
<tr>
<td>22</td>
<td>C2</td>
<td>C3</td>
<td>C5</td>
<td>P6</td>
<td>P1</td>
<td>P4</td>
</tr>
<tr>
<td>23</td>
<td>P6</td>
<td>P2</td>
<td>P1</td>
<td>C4</td>
<td>C3</td>
<td>C5</td>
</tr>
<tr>
<td>24</td>
<td>P6</td>
<td>P1</td>
<td>P4</td>
<td>C2</td>
<td>C5</td>
<td>C3</td>
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<tr>
<td>25</td>
<td>P3</td>
<td>P1</td>
<td>P6</td>
<td>C2</td>
<td>C5</td>
<td>C4</td>
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<td>26</td>
<td>C2</td>
<td>C4</td>
<td>C1</td>
<td>P6</td>
<td>P3</td>
<td>P5</td>
</tr>
<tr>
<td>27</td>
<td>C4</td>
<td>C2</td>
<td>C3</td>
<td>P5</td>
<td>P1</td>
<td>P6</td>
</tr>
<tr>
<td>28</td>
<td>P6</td>
<td>P5</td>
<td>P1</td>
<td>C3</td>
<td>C2</td>
<td>C4</td>
</tr>
<tr>
<td>29</td>
<td>C1</td>
<td>C6</td>
<td>C4</td>
<td>P2</td>
<td>P5</td>
<td>P3</td>
</tr>
<tr>
<td>30</td>
<td>C1</td>
<td>C2</td>
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<td>C2</td>
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<th>C4</th>
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<td>36</td>
<td>P5</td>
<td>P2</td>
<td>P6</td>
<td>C3</td>
<td>C4</td>
<td>C1</td>
</tr>
</tbody>
</table>

Note: P= passages presented on paper, C=passages presented on computer

**Computer Presented Stimuli**

After silently reading a passage on the computer screen subjects in this condition were given six reading comprehension questions on paper and circled the correct response. After the subjects completed the six comprehension questions they were presented a different reading passage, on the screen, by depressing the left button on the computer keyboard’s mouse. This procedure was repeated until the subject had read three passages and had completed three sets of comprehension questions (see Appendix A).

**Paper Presented Stimuli**

After silently reading a passage on paper subjects in this treatment condition read six multiple-choice reading comprehension questions presented on paper and circled the correct response. After completing the six reading comprehension questions on paper the subject was given another reading passage on paper.

This procedure was repeated until the subjects had silently read three printed passages and completed three sets of comprehension questions (see Appendix A).
Vocabulary Test

After the subjects had completed the two reading conditions (COMP and PP) they were presented with a thirty question vocabulary test, printed on paper, and responded by circling the correct response (see Appendix B).

Overview of Variables, Design, and Analysis

The following independent variables were considered in one or more of the analyses conducted on the experimental data: a) experimental treatment conditions, and b) reading achievement. The experimental treatment conditions are:

Treatment No. 1

Subjects silently read three experimental passages from a computer screen. Subjects completed six multiple-choice comprehension questions, on paper with a pencil, after reading each passage.

Treatment No. 2

Subjects silently read three experimental passages from printed pages. As in the above treatment condition, the subjects completed six multiple-choice comprehension questions, on paper using a pencil, after reading each passage.

Three levels of reading achievement: (1) readers with a learning disability, (2)
low readers, and (3) average readers, were determined through the use of standardized reading ability instruments.

The dependent variables which were considered in the design of this study include:

1. Reading comprehension of experimental passages, presented as text printed on paper, as measured by 6 multiple-choice questions following each passage. Reading comprehension levels were determined using the number of correct for each passage and tallying the total scores for the three passage tests.

2. Reading comprehension of computer presented text as measured by 6 multiple-choice questions following each passage. Reading comprehension levels were determined using the number of correct for each passage and tallying the total scores for the three passage tests.

3. Vocabulary or word meanings in the experimental passages as measured by a multiple-choice vocabulary test. The level of vocabulary was determined by the number of correct responses to the vocabulary items.

Study Questions and Research Hypotheses

The questions that were the focus of this study are listed below. For each question a research hypothesis was written in the form of a null hypothesis. The literature (Beck et al., 1991; Brophy, 1996; Horton & Lovitt, 1994; Neal, 1991) indicates the appropriateness of nondirectional hypotheses for the effect of presentation media on
reading comprehension. Given the documented concerns with this population of students, it was felt that a conservative and nondirectional approach was the most prudent avenue to pursue.

Study Question 1

Is there a difference in reading comprehension for students with learning disabilities based upon medium of presentation?

Research Hypothesis 1

There will be no significant differences in reading comprehension scores for students with learning disabilities whether reading from computer-displayed text or paper-displayed text.

Study Question 2

Is there a difference in reading comprehension scores for students who are low readers when reading from computer generated text or from printed text?

Research Hypothesis 2

There will be no significant differences in reading comprehension scores for students who are low readers whether reading from computer-displayed text or paper-displayed text.
Study Question 3

Is there a difference in reading comprehension for students who are average readers based upon medium of presentation?

Research Hypothesis 3

There will be no significant differences in reading comprehension scores for students who are average readers whether reading from computer-displayed text or paper-displayed text.

Study Question 4

Is there a difference in reading comprehension measured by vocabulary scores for students with Learning Disabilities when reading from computer generated text or from printed text?

Research Hypothesis 4

There will be no significant differences in vocabulary recall scores for students with learning disabilities whether reading from computer-displayed text or paper-displayed text.

Study Question 5

Is there a difference in reading comprehension measured by vocabulary scores
for students who are low readers when reading from computer generated text or from printed text?

**Research Hypothesis 5**

There will be no significant differences in vocabulary recall scores for students who are low readers whether reading from computer-displayed text or paper-displayed text.

**Study Question 6**

Is there a difference in reading comprehension measured by vocabulary scores for students who are average readers when reading from computer generated text or from printed text?

**Research Hypothesis 6**

There will be no significant differences in vocabulary recall scores for students who are average readers whether reading from computer-displayed or paper-displayed text.

**Study Question 7**

Is there an interaction effect between a student's reading achievement group and the presentation media on reading comprehension?
Research Hypothesis 7

There will be no significant interaction effect between the student’s reading achievement group and the presentation media on reading comprehension scores.

Study Question 8

Is there an interaction effect between a student’s reading achievement group and the presentation media on vocabulary recall?

Research Hypothesis 8

There will be no significant interaction effect between the student’s reading achievement group and the presentation media on vocabulary recall scores.

Data Analysis Procedures

This research used a Completely Randomized Factorial Design (CRF-32) for subject assignment and data analysis. This design is appropriate because it meets the criteria defined by Kirk (1968): (a) it contains two or more treatments with each treatment having two or more levels, (b) the subjects were randomly assigned to the treatment conditions, and (c) each subject received one combination of treatment, within three subject classifications. The design is based upon repeated measures across two treatment conditions within three subject groups.
The data were analyzed to determine the main effect of presentation media on reading comprehension and vocabulary recall. The interactive effect between reading achievement group and method of text presentation also was analyzed. Data were analyzed using a repeated analysis of covariance (ANCOVA) with a predetermined alpha level of .05 (Hinkle, Wiersma, & Jurs, 1998) to determine significance. The use of the ANCOVA is appropriate for data analysis in this study because it complies with the conditions set forth by Wildt and Ahtola (1978), (a) it increases precision in randomized experiments, and (b) it removes bias due to nonrandom assignment of group membership. The covariant used in the data analysis was the reading performance score on the ITBS of subjects in each group. Reading performance was selected as the covariant so that the effect of presentation media on each ability group could be analyzed without the influence of each group members reading performance impacting the results. The ANCOVA procedure provides a method to adjust for the differing performance levels of group members who have been nonrandomly assigned to groups. This condition of nonrandom assignment exists because the students were placed into groups based upon preexisting differences in reading performance. The use of the ANCOVA procedure may produce more precise results similar to the use of randomized experimental procedures by reducing error variance (Wildt & Ahtola, 1978).

The power of the instrument used for data analysis was considered when selecting a sample size for the experiment. The SAS macro program, fpower.sas, was used to determine the sample size which was required to satisfy the power requirement for the
ANCOVA test (Cohen, 1988). The SAS program determined, for an alpha level of .05 and an effect size of .75, a sample population for an experiment with a 3 by 2 design would need to be at least 25 subjects. This study used 36 subjects.

Prior research (Brophy, 1996; Neal, 1991; Reinking, 1983), which examined similar conditions relied upon Analysis of Variance (ANOVA) for data analysis. The ANOVA procedure was not appropriate for use in this study due to the conditions outlined above. Data analysis was performed on a Packard Bell desk top computer using SPSS Statistical Software Version 8 and on a Dell desktop computer using SAS Statistical Software Version 6.12.

Summary

This chapter has described the research population, experimental design, instrumentation, materials, procedures, and data analysis methods for the replication of this study. The next chapter will report the results of the data analysis.
CHAPTER IV

ANALYSIS OF DATA

Introduction

The purpose of this study was to investigate the effects of presentation media on reading comprehension. Three groups of students were used: (1) Readers with a learning disability, (2) Low readers, and (3) Average readers. The measures used were scores on reading comprehension and vocabulary recall.

Eight research hypotheses were made and will be presented and addressed in this chapter, accompanied by descriptions of the analytical procedures and a summary of the findings. Data relevant to the research questions posed in Chapter Three will also be presented.

Results

Following the procedures described by Beck et al. (1991) and Neal (1991), two types of reading comprehension measures were used to test the effects of experimental conditions: (1) Reading comprehension, and (2) Vocabulary recall. Subjects in the treatment groups responded to six multiple-choice comprehension questions after silently reading each passage. The number of correct responses for each subject were totaled. The
maximum possible score was 18 for each type of media presented.

Immediately following the completion of the 36 multiple-choice questions, the subjects were asked to complete the 30 question vocabulary instrument. The number of correct responses were summed. The total possible correct was 15 for each media. Group performance scores, presented as means and standard deviations, are presented in Table 5.

Research Hypothesis 1

Research hypothesis one states that there will be no significant differences in reading comprehension scores for students with learning disabilities whether reading from computer-displayed text or paper-displayed text.

Research Hypothesis 2

Research hypothesis two states that there will be no significant differences in reading comprehension scores for students who are low readers whether reading from computer-displayed text or paper-displayed text.
<table>
<thead>
<tr>
<th>Presentation Media</th>
<th>Reading Comprehension</th>
<th>Vocabulary Recall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Computer</td>
<td>Paper</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Readers with L.D.</td>
<td>7.42</td>
<td>2.87</td>
</tr>
<tr>
<td>Low Readers</td>
<td>7.83</td>
<td>2.66</td>
</tr>
<tr>
<td>Average Readers</td>
<td>11.00</td>
<td>2.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Research Hypothesis 3**

Research hypothesis three states that there will be no significant differences in reading comprehension scores for students who are average readers whether reading from computer-displayed text or paper-displayed text.
To test differences between the means for the two comprehension scores for each group, a repeated measures Analysis of Covariance (ANCOVA) was computed using presentation media and reading achievement group as the independent variables, reading comprehension score as the dependent variable, and the reading performance score on the ITBS as the covariate (Wildt & Ahtola, 1978). Table 6 shows that no significant differences were indicated at the \( p < .01 \) - \( p < .05 \) level for students' mean reading comprehension scores, for each group, across the two treatment conditions.

Table 6

Repeated Measures Analysis of Covariance for Reading Comprehension Scores

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
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<tr>
<td>Reading Achievement Group</td>
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<tr>
<td>Presentation Media</td>
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<td>.24</td>
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<tr>
<td>Group x Media</td>
<td>2</td>
<td>1.47</td>
</tr>
<tr>
<td>Performance</td>
<td>32</td>
<td>2.51**</td>
</tr>
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</table>

* \( p < .05 \), ** \( p < .01 \).

Based on these results, research hypotheses one, two, and three were accepted. No significant differences in the range of \( p < .05 \) to \( p < .01 \) were found to exist between reading comprehension scores across achievement groups and presentation media.


Research Hypothesis 4

Research hypothesis four states that there will be no significant differences in vocabulary recall scores for students with learning disabilities whether reading from computer-displayed text or paper-displayed text.

Research Hypothesis 5

Research hypothesis five states that there will be no significant differences in vocabulary recall scores for students who are low readers whether reading from computer-displayed text or paper displayed text.

Research Hypothesis 6

Research hypothesis six states that there will be no significant differences in vocabulary recall scores for students who are average readers whether reading from computer-displayed text or paper displayed text.

To test differences between means for the two vocabulary scores, for each group, a repeated measures ANCOVA was computed using presentation media and reading achievement group as the independent variables, vocabulary recall score as the dependent variable, and the reading performance scores on the ITBS as the covariate. Table 7 shows that no significant differences were indicated at the $p<.01 - p<.05$ level for
students’ mean vocabulary recall scores, for each group, across the two treatment conditions.

Table 7

Repeated Measures Analysis of Covariance for Vocabulary Recall Scores

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<thead>
<tr>
<th>Source</th>
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<tr>
<td>Reading Achievement Group</td>
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<tr>
<td>Presentation Media</td>
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<td>.30</td>
</tr>
<tr>
<td>Group x Media</td>
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<td>.03</td>
</tr>
<tr>
<td>Performance</td>
<td>32</td>
<td>3.06**</td>
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</table>

* p<.05, ** p<.01.

Based on these results, research hypotheses four, five, and six were accepted. No significant differences in the range of p<.05 to p<.01 were found to exist between vocabulary recall scores across reading achievement groups and presentation media.

Research Hypothesis 7

Research hypothesis seven states that there will be no significant interaction effect between the student’s reading achievement group and the presentation media on reading comprehension scores.
An ANCOVA was calculated using the reading comprehension scores to determine if an interaction effect exists between reading achievement group and presentation media. The results of the ANCOVA of reading comprehension data shown in Table 6, indicate that there was not a significant effect for treatment conditions \( (F = 1.47) \). Thus, there was no significant difference in the mean passage-based comprehension scores in the two treatment conditions across the three achievement groups. In addition, there was a significant effect for reading performance \( (E = 2.51, p< .01.) \) indicating a significant difference in the mean passage-based comprehension scores for subjects in the three reading achievement groups.

The results of the analysis of reading passage-based comprehension scores indicate that students in the two treatment conditions were able to comprehend similar amounts of information. However, the student's ability to comprehend information was significantly different across the three achievement groups and there was no significant interaction between the treatment conditions and reading achievement groups on the comprehension of information.

Based on these results, research hypothesis seven is accepted. No significant interaction effect in the range of \( p< .05 \) to \( p< .01 \) was found to exist between reading achievement group and presentation media on reading comprehension.
Research Hypothesis 8

Research hypothesis eight states that there will be no significant interaction effect between the student's reading achievement group and the presentation media on vocabulary recall scores.

An ANCOVA was calculated, using the vocabulary recall scores, to determine if an interaction effect exists between reading achievement group and presentation media. The results of the ANCOVA in regard to vocabulary recall data are shown in Table 7. The results indicate that there was not a significant effect for treatment conditions ($F = .03$). Thus, there was no significant difference in the mean vocabulary recall scores of the two treatment conditions across the three achievement groups. In addition, a significant effect for reading achievement group ($F = 3.06, p< .01$) was found indicating there was a significant difference in the mean vocabulary recall scores for subjects in the three reading achievement groups.

The results of the analysis of vocabulary recall scores indicate that students in the two treatment conditions were able to recall similar amounts of word meanings. However, the students' ability to recall vocabulary words was significantly different across the three achievement groups and there was no significant interaction between the treatment conditions and reading achievement groups on vocabulary recall.
Based on these results, research hypothesis eight is accepted. No significant interaction effect in the range of \( p < .05 \) to \( p < .01 \) was found to exist between reading achievement group and presentation media on vocabulary recall.

Summary

The data presented in this chapter support the interpretation that presentation medium has no effect on the comprehension of reading material by readers with a learning disability. This interpretation is supported by the data as measured by reading passage comprehension and vocabulary word recall. These findings will be discussed and the conclusions will be summarized in Chapter Five.
CHAPTER V

DISCUSSION

Introduction

The purpose of this study was to investigate the effect of presentation media on reading comprehension in students with a learning disability. Data collection was performed through the use of an experimenter-created instrument on paper and on a laptop computer LCD screen. The data collected were used to analyze the students reading comprehension and vocabulary recall from short reading passages read from the two display mediums.

Overview of Chapter

The purpose of this chapter is to discuss the research findings and conclusions from this study, and implications for educational practices, where appropriate, for students with learning disabilities. Discussion includes: (a) a summary of the findings, (b) implications and recommendations, (c) limitations of the study, and (d) directions for further study.
Summary of Findings

This study sought to investigate the relationship between presentation media on reading comprehension of students with learning disabilities. This study was a investigation into the reliability of findings from previous studies based on computer platforms that are obsolete. Earlier studies (Reinking, 1983; Venezky, 1994) presented material to readers on monitors which did not have the resolution of currently used models. This study attempted to determine whether there is a relationship between the reading achievement of middle grades students and the method that was used to display reading passages. This study examined the results of two measures of reading comprehension to determine if the display media and the reading achievement of the students interacted to affect the students reading comprehension. The first instrument measured the students' ability to recall factual information presented with the short reading passage using a multiple-choice format. The use of an multiple-choice instrument to measure the student's comprehension of previous read information is supported by previous studies (Brophy 1996; Neal, 1991; Reinking, 1983). The instrument which was used in this study was tested for reliability and validity by Reinking in his work on reading comprehension. His study found that there was no significant difference between traditionally printed text and computer-generated text on reading comprehension scores for general education readers. Neal (1991) determined that there was no significant difference in the scores for high school-aged students on
reading ability whether using a paper and pencil version or a computerized version of a reading achievement examination.

The second instrument used to measure reading comprehension in this study was a 30-item vocabulary word meaning recall instrument. The vocabulary instrument required the students to select a word meaning from a multiple-choice list of word meanings. The correct response was a word that was similar to a word from the short reading passage. Again, the purpose of the vocabulary instrument was to measure the difference in the student’s reading comprehension from computer-displayed text and from printed text. This instrument was previously used in the study by Reinking (1983). The current study, unlike the Reinking study, was undertaken to determine the effect of presentation medium on the reading comprehension of students with learning disabilities. Brophy (1996) in her study of the effect of interactive hypermedia on reading comprehension used similar instruments but with a population of general education students. Her research was also unable to determine a significant difference in comprehension scores between computer presented and printed text.

The present trend of educating many learning disabled readers in general education classrooms, in an attempt to comply with the least restrictive environment provision of the Individual with Disabilities Education Act (IDEA), has created the need for educational research to investigate the use of alternative methods for meeting the specific educational needs of this unique population (McLesky, Henry, & Axelrod, 1999). The current use of computer technology in the educational environment to
perform various teaching and management tasks would allow for a transition from teacher-based instruction to computer-based instruction for students with learning disabilities. The results of this study, no significant difference in reading comprehension from one display medium to another, as well as those of others researchers, would lend support to the use of computers to supplement reading instruction for students with learning disabilities.

In this study, the power of the instrument used for data analysis was considered when selecting a sample size for the experiment. The SAS macro program, fpower.sas, was used to determine the sample size which was required to satisfy the power requirement for the ANCOVA test (Cohen, 1988). The SAS program determined, for an alpha level of .05 and an effect size of .75, a sample population for an experiment with a 3 by 2 design would need to be at least 25 subjects. This study used 36 subjects in three unique treatment groups. The three groups were: (1) learning disabled readers, (2) low readers, and (3) average readers. Group membership was determined by the school district through the use of previously established Special Education and Title I screening procedures. This group membership was supported through the use of the Iowa Test Of Basic Skills (ITBS) which is administered annually to all students in Georgia. The reading comprehension score which was used as the determining variable for group membership was reported as a grade equivalent (GE) score. Students were ranked according to the variance between their grade level and the reported GE score. The greater the variance between the two grade levels the higher the ranking. The twelve
students who had the greatest variance between the two scores were included as students
with learning disabilities. There was a significant correlation between their classification
as students with learning disabilities in reading and the variance between their two
reading scores.

The inability of this study to determine a significant difference between the
comprehension levels of the three treatment groups whether reading from computer-
displayed reading passages and paper-displayed reading passages is significant. This can
be interpreted as support of previous studies that reported similar results. This may result
in the continued use of, and perhaps increased use of, computerized educational
instruction for special education students and especially with students with learning
disabilities. The results of this study may be used to answer some of the concerns posed
by Waller (1996) and others about the efficacy of computerized reading instruction but
they also appear to lead to additional questions about this use. This study attempted to
clarify questions related to the original foundations of computerized instruction in
reading in an attempt to reexamine several of the hypotheses, which were studied on
older computer platforms, to determine if the results continue to be generalizable to
current teaching practices. As a result of this study additional studies should be
undertaken so that the process of reexamination can be continued. These are described
on page 65.

The results of this study may not be generalizable to other populations due to
several of the unique characteristics of the population from which this sample was drawn.
The level of understanding of the three groups of readers was significantly different from each other, however, there was no significant difference in understanding based upon an interaction effect between their ability and the presentation media. The performance scores of the three groups of students were similar for the two levels of treatment. All three groups performed at the same level regardless of group membership. Low readers performed better than readers with learning disabilities and ability readers performed better than low readers. All three groups appeared to learn information from either method of reading passage presentation. The students appeared to perform just as well regardless of the treatment condition. There did not appear to be any deleterious effect from reading computer-displayed material. On the other hand no significant benefit seemed to be gained from reading computer displayed material. It appears that the students' reading performance is a result of reading ability more than it is a result of method of display. The scores from both the reading comprehension instrument and the vocabulary instrument indicate similar results. The students recalled significantly different amounts of information according to their reading achievement group regardless of treatment condition.

Limitations of Study

There are several apparent limitations of this study which suggest that these results should be viewed cautiously. First, the research population included only one school in southwest Georgia. Different results could occur with a greater number of data...
collection sites over a larger geographic area. Second, the sample size and school were relatively small. Larger sample sizes and larger schools might produce different results. Third, the racial composition of the sample population is not representative of the racial distribution of the nation. A more racially diverse sample might yield results which are more generalizable.

Another limitation is that extraneous variables that were not controlled for may have an effect or relationship on the data that was collected. Extraneous variables such as school environment factors, student's prior computer use, and personal history may have affected the outcomes of this research.

This study is also limited by the dependent measures used to determine the effects of the treatment conditions. The comprehension and vocabulary measures were both administered on paper and alternating between reading from a computer screen to answering questions on paper may have affected the results of the study. Finally, with few empirical studies of this nature available, comparisons of the results of this study to others is extremely limited.

Directions for Further Research

During the course of this research seven areas in need of further study arose:

1. The replication of this study with a larger sample from a more diverse population would allow greater generalization of the results.

2. The research design could be expanded to include measurement of the time
it takes students to read material from a computer screen and from material printed on paper. This should be an additional variable to be considered in this research.

3. This study focused on the impact of presentation media on reading comprehension and vocabulary word recall. Future research should include an investigation into the effect of presentation media on reading fluency.

4. This study focused primarily on the impact of presentation media on the initial learning of computer-based and paper-based material. Future research should examine the impact of presentation media on drill and practice instruction.

5. The research design of this study should be expanded to include the use of hypertext as one of the available options on the computer-based presentation of materials. This would allow for the use of one of many options available on a computer but not available on paper presented material.

6. This study is limited to the presentation of one-page materials both on the computer screen and on paper. Future research should examine the effect of presentation media on the comprehension of information from multiple-page documents.

7. An expansion of this study which should be explored is the effect of reading both the reading comprehension and vocabulary instruments and responding to them on computer and on paper after reading the passages.

In summary, while this research leaves many more questions unanswered than answered, one important question remains from this research. Should computers be used as a replacement for printed material in reading instruction? This question, while beyond
the scope of this study, is an important one to be considered. Based upon the results of this study and other research the answer is not simply a matter of which works better for students but other more cogent issues need to be addressed. Not the least of these issues is cost effectiveness.
Appendix A

Comprehension Instrument
Passage 1 Questions

Number:__________

Choose the best answer for each question. Circle the number of your choice beside each sentence. Once you have made your choices go on to the next question.

1. What does this passage say about hail?
   1. It most often falls over a large area.
   2. It falls mainly in the winter.
   3. It usually falls near a city.
   4. It usually falls before a storm.

2. What may cause hail?
   1. Raindrops being blown up and down.
   2. Lightning striking raindrops.
   3. Snow melting raindrops.
   4. Raindrops falling through cold air.

3. When do hailstones form?
   1. On very cold days.
   2. During sudden movements of air.
   3. When the air is mostly calm.
   4. During a snowstorm.

4. How do hailstones become larger?
   1. When they fall through cold air.
   2. When they are blown slowly upward.
   3. When they rise and fall several times.
   4. When they fall through air close to the earth.

5. What does this passage say about sleet and hail?
   1. They often happen at the same time.
   2. They happen in different seasons.
   3. They happen when the weather is below freezing.
   4. They both happen before a summer storm.

6. How is sleet formed?
   1. Hail melts and becomes sleet.
   2. Raindrops are held in a cold-air cloud.
   3. Sleet is made like hail but is in winter.
   4. Raindrops freeze before they hit the ground.
Passage 2 Questions

Choose the best answer for each question. Circle the number of your choice next to each sentence. Once you have made your choice, go on to the next question.

1. What does this passage say about Mercury?
   1. It is about the size of the earth.
   2. It is farther from the sun than the earth.
   3. It is closer to the sun than the earth.
   4. It faces earth like our moon.

2. Most places on Mercury’s surface have
   1. Both day and night once each trip around the sun.
   2. Either day or night all of the time.
   3. A short day most of the time.
   4. Day and night a few times each year.

3. What does the passage say about Mercury’s daylight side?
   1. It is cold when the sun sets.
   2. It is cold when it is in the twilight zone.
   3. It is hot or cold depending where the sun is.
   4. It is always hot.

4. Mercury always faces the sun like
   1. The earth faces the sun.
   2. The moon faces the earth.
   3. All the planets face the sun.
   4. The moon faces Mercury.

5. On a small part of Mercury the sun rises and sets. How often does this happen?
   1. Several times each trip around the sun.
   2. Once every 24 hours.
   3. Once every 3 earth years.
   4. Whenever the sun moves in front of Mercury.

6. On Mercury where is the twilight zone?
   1. Where the sun is never seen.
   2. Where the sun always shines.
   3. Where the sun never rises.
   4. Where the sun rises and sets.
Passage 3 Questions

Choose the best answer for each question. Circle the number of your choice beside each sentence. Once you have made your choice, go on to the next question.

1. What do experts think should have happened to the Great Salt Lake?
   1. It should have become less salty by now.
   2. It should have become larger over the years.
   3. It should have disappeared long ago.
   4. It should have changed shape many years ago.

2. What lives in the Great Salt Lake?
   1. Small animals and simple plants.
   2. Fresh water fish but no plants.
   3. No life at all because it is too salty.
   4. Several kinds of large ocean fish.

3. What is algae?
   1. A kind of march grass.
   2. A type of shore bird.
   3. A simple form of plant life.
   4. A particular kind of shrimp.

4. What does the passage say about the size of the Great Salt Lake?
   1. It has stayed much the same through history.
   2. It has changed many times in the past.
   3. It has always been smaller than it is now.
   4. It has quickly become smaller in recent years.

5. There is a plan for taking water from
   1. The basin around the lake.
   2. The Great Salt Lake.
   3. The nearby Green River.
   4. Streams that feed the Great Salt Lake.

6. What could happen to the lake if present plans are carried out?
   1. The lake will probably stay the same.
   2. The lake may be a better place for fish.
   3. The lake may get bigger than it is now.
   4. The lake may dry up faster before too long.
Passage 4 Questions

Choose the best answer for each question. Circle the number of your choice beside each sentence. Once you have made your choice, go on to the next question.

1. What were pots and pans made of in the 14th century?
   1. Iron
   2. Silver
   3. Precious jewels
   4. Copper

2. In the time of Edward III, why were pots and pans so valuable?
   1. They were very delicate.
   2. They were extremely useful.
   3. They were rare.
   4. They were ornate.

3. What happened to Edward’s pots and pans when he traveled?
   1. They were locked up until his return.
   2. They were taken along on the trip.
   3. They were replaced with new cookware.
   4. They were used by his grandson.

4. What does this passage say about Henry V’s cookware?
   1. It was plain and made of iron.
   2. It was made of a valuable metal.
   3. It was never used.
   4. It was used only for special occasions.

5. In the 16th century what made the king’s cookware different from earlier cookware?
   1. It was made of silver.
   2. It was more greatly decorated.
   3. It was now kept in the kitchen.
   4. It was no longer owned by the king.

6. Many years ago in England pots and pans were
   1. Rarely used.
   2. Given as presents.
   3. Taken for granted.
   4. Special
Passage 5 Questions

Number

Choose the best answer for each question. Circle the number of your choice next to each sentence. Once you have made your choice, go on to the next question.

1. What does the passage say about film?
   1. It is thick, solid plastic.
   2. It has several different layers.
   3. It is easily scratched.
   4. It is made from a negative.

2. What is the purpose of the antihalation coating?
   1. To prevent scratches.
   2. To bind the film together.
   3. To record the image.
   4. To prevent light from bouncing back.

3. What part of the film records the image?
   1. A clear plastic base.
   2. An emulsion of silver grains.
   3. A dull coating.
   4. A mirror-like coating.

4. When film is developed, what happens to silver grains that were hit by light?
   1. They fade.
   2. They become black.
   3. They are washed away.
   4. They become larger.

5. What happens to the silver grains not touched by light?
   1. They are left on the film.
   2. They are washed away by chemicals.
   3. They are fixed by the chemicals.
   4. They turn black on the negative.

6. Where are the light and dark parts reversed?
   1. On the negative.
   2. On the antihalation layer.
   3. On the plastic base.
   4. On the transparent coating.
Passage 6 Questions

Number________

Chose the best answer for each question. Circle the number of your choice beside each sentence. Once you have made your choices go on to the next question.

1. Why was salt so important long ago?
   1. Food did not taste very good.
   2. It kept food from spoiling.
   3. Soldiers used it to make gunpowder.
   4. It could be used in building roads.

2. Which of these things happened because people needed salt?
   1. Towns were started and roads were built.
   2. People began to eat more food.
   3. Soldiers began to earn more money.
   4. Trade began between Rome and Ostia.

3. Which of these reasons explains why Ostia was important?
   1. It was the site of salt beds.
   2. It was a camp for soldiers.
   3. It was a place for rich Romans to get salt.
   4. It was a trade center for soldiers.

4. What did many of the first trade routes join?
   1. Rome and Ostia with other cities.
   2. One salt bed to another.
   3. Towns and salt beds.
   4. Rome and the Via Salaria.

5. What was “salary” to the Roman soldier?
   1. A vegetable that needed salt.
   2. Silver in place of salt.
   3. Salt used for pay.
   4. A road that carried salt.

6. What was the Via Salaria?
   1. A military road for moving troops.
   2. A soldiers allowance.
   3. A road joining two salt beds.
   4. A road from Rome to Ostia.
Appendix B

Vocabulary Instrument
VOCABULARY TEST

Number ____________________

Directions: The underlined words below are from the six passages you have read. Below each underlined word are four words or word pairs. Choose the word or word pair that is closest in meaning to the underlined word as it was used in one of the passages. Circle the correct one.

Example:

draft
A. Written order
B. Sudden wind
C. First try
D. Cold raindrop

1. **Scarce**
   A. Not much
   B. Be afraid
   C. Not willing
   D. Get away

2. **Preserve**
   A. Remember
   B. Jam
   C. Save
   D. Support

3. **Bed**
   A. Moisture
   B. Layer
   C. Furniture
   D. Mat

4. **Ancient**
   A. History
   B. Valuable
   C. Past
   D. Crazy

5. **Ornate**
   A. Decorated
   B. Charming
   C. Irregular
   D. Emphasis
6. **Chased**
   A. Followed
   B. Extended
   C. Lined
   D. Improved

7. **Ascend**
   A. Revise
   B. Climb
   C. Wade
   D. Promote

8. **Monarch**
   A. Butterfly
   B. Official
   C. Grandson
   D. Ruler

9. **Reign**
   A. Corps
   B. Wild
   C. Rule
   D. Alone

10. **Transparent**
    A. Clear
    B. True
    C. Across
    D. Drive

11. **Thrive**
    A. Live under
    B. Grow easily
    C. Make falsely
    D. Save early

12. **Westminster**
    A. Kitchen
    B. Palace
    C. Cook
    D. Invention
13. Spit
   A. Planet
   B. Palace
   C. Cough
   D. Rod

14. Compound
    A. Prison
    B. Crossing
    C. Mixture
    D. Difficult

15. Lavishly
    A. Fully
    B. Deeply
    C. Occasionally
    D. Possibly

16. Ward
    A. City part
    B. Hospital room
    C. Protect against
    D. Lift up

17. Fraction
    A. Thick layer
    B. Solve problems
    C. Small part
    D. Break off

18. Emulsion
    A. Light sensitive
    B. Thick printing
    C. Shiny finish
    D. Rough edges

19. Griddles
    A. Copper coverings
    B. Large irons
    C. King’s jewels
    D. Flat pans

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20. **Dull**
   A. Not smart
   B. Not shiny
   C. Not sharp
   D. Not sunny

21. **Basin**
   A. Lake marsh
   B. Ground level
   C. Water bowl
   D. Shallow dip

22. **Primitive**
   A. Old way
   B. Faraway place
   C. Simple form
   D. Rich tribe

23. **Source**
   A. Everything
   B. Name
   C. Information
   D. Beginning

24. **Rotate**
   A. Open
   B. Turn
   C. Start
   D. Form

25. **Algae**
   A. Plants
   B. Mountains
   C. Fish
   D. Marshes

26. **Roost**
   A. Store
   B. Build
   C. Sleep
   D. Fly
27. Face
   A. Side
   B. Reach
   C. Look
   D. Rock

28. Divert
   A. Cook well
   B. Trade openly
   C. Make fun
   D. Turn aside

29. Grains
   A. Cereals
   B. Lines
   C. Particles
   D. Patterns

30. Royal arms
   A. Special pictures
   B. Powerful weapons
   C. King's hands
   D. Lovely pots
Appendix C

Experimental Reading Passages
Passage 1

As a rule, hail is formed mostly in the summer. It often falls over a small region in very hot weather. Thunderstorms usually follow the hail.

No one knows for sure how hailstones form. One belief is that the stones are raindrops that are caught in drafts of stormy air. The drops are blown high up, where the air is very cold. After freezing, they drop down. This happens more than once. Each time the stones are blown upward they get heavier. They grow so large the air can't hold them and they fall to the ground.

Sleet looks like hail. It falls in winter. Sleet is made of raindrops that freeze as they fall through a layer of cold air.
Passage 2

Mercury, is the planet that is nearest the sun. Like all planets it travels around the sun and rotates at the same time. Mercury rotates at a speed which keeps one face of the planet constantly toward the sun. Our moon behaves the same way. One side of the moon always faces the earth.

Because one side of Mercury constantly faces the sun, that side is baked. The other side is eternally frozen. One side has never-ending daylight the other has eternal night.

Mercury’s spin is not perfectly matched to its trip around the sun, however. Because of this, there is a narrow strip that has something like day and night. A few times during its trip around the sun, the sun will rise and set on a small region of Mercury’s surface. This area between the light and dark sides is called the twilight zone.
Passage 3

Picture a still, shallow lake at the bottom of a huge basin. Long after experts insist it should have dried up, the Great Salt Lake of Utah, America’s so-called Dead Sea, still exists.

The supposedly dead lake has no fish, but millions of tiny shrimp and several forms of algae, primitive plant life, thrive there in waters saltier than the ocean. Gulls roost on islands in the lake and shore birds nest in the marshes around it.

Ancient beaches high on the sides of the surrounding mountains show that the lake once covered more than twenty times its present area. Other evidence shows that the lake has completely dried up several times in its history.

The lake’s level has not dropped much in the last hundred years, despite increased use of water from its sources for irrigation. Current plans for diverting the Green River into the basin around the lake may even increase the lake’s present size.
Passage 4

Pots and pans were once considered to be precious possessions. In the fourteenth century, during the reign of Edward III of England, the pieces of cookware—iron pots, griddles, spits, and frying pans—were numbered among the king's jewels. They were difficult to come by and, being rare, were extremely valuable; when the monarch went on a journey or made a visit, the pots and pans traveled along in a separate coach.

By the time Henry V, Edward's grandson, ascended the throne in the following century, the royal frying pans were made of silver, and so were the roasting spits.

The kettles at Westminster during the early sixteenth century, when Henry VIII held the throne, were "copper-gilt" and quite lavishly decorated with chasing. The handles of the cooking ladles were chased with the royal arms, and one of the two-pronged toasting forks is known to have been made from silver.
The film used in photography is only a fraction of an inch thick, but is composed of many layers. The thickest part is a hard transparent coating that helps ward off scratches. Under the base is an antihalation coating. This coating is dull, to prevent light from bouncing back through the film as from a mirror.

The part of the film that records the image is the emulsion. It is a silver compound containing thousand of grains of silver. Light rays hitting the grains disturb them so that when the film is developed in chemicals the disturbed grains turn black and remain on the film. Another chemical process washes away the grains not touched by light, and at the same time fixes the disturbed, or exposed grains.

The result is a negative—a transparent film image in which light and dark parts of the original subject are reversed.
In ancient times, salt was hard to find. It was in great demand, since it could preserve food. Salt was thus a valuable item for trade. New towns often grew up if salt beds were found nearby. In fact, the first trade routes were roads that joined salt beds to the large towns.

One of the oldest Roman roads was built because of the need for salt. This road stretched from Rome to Ostia, on the west coast of Italy. At the coast were salt beds. It was a short route of fourteen miles. Over this road came the “white salary.” This was the salt allowance paid to each Roman soldier. As a result the road was called the Via Salaria.
Appendix D

Human Subjects Institutional Review Board Approval Letters
Date: 19 April 2000

To: George Haus, Principal Investigator  
    Jeffrey Conklin, Student Investigator for dissertation

From: Sylvia Culp, Chair

Re: HSIRB Project Number 00-03-06

This letter will serve as confirmation that your research project entitled "The Effect of Presentation Medium on Student's Reading Comprehension" has been approved under the exempt category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may only conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: 19 April 2001
Training Instructions for Subjects

Good morning, You have been asked to be part of a project called “The Effect of Presentation Media on Reading Comprehension.” The purpose of this project is to see if students, like yourselves, understand and remember more from stories which they read on a computer or on paper.

You will be given six stories to read, questions to answer about what I have read, and vocabulary questions. You will read three of the stories on the computer and three of the stories from a piece of paper. You will then answer the questions on a piece of paper. This test will take only one class period. You will not get any extra credit, and if you don’t wish to join in, there will be no effect on your school grades. Even if you agree today to join in you can change your mind any time when we begin testing or any time during testing.

Don’t put your name on any of the forms. I will use a secret code number instead. I will keep a list of names and secret code numbers that will be destroyed once I have completed his study.

If you have any questions or concerns about this study, you may contact either your principal Mr. Burke, or your teacher, or you can ask them right now.
Now I will explain the testing process to you. You will be placed in front of a laptop computer like this one here. On the front of the keypad, this is the keypad, is the mouse button. You will be asked to read three stories from the computer screen. When you are told to begin, the screen on the laptop will be black, like it is now. When you are told to begin, you press this mouse button like this, and a story will come up on the screen, just like this. Begin reading the story. When you are finished reading the story, press the mouse button and the screen will go black, just like this. Then raise your hand and I will give you 1 paper with six multiple-choice questions on it. Read and answer the questions on the paper as best as you can. When you are finished with the questions, simply press the mouse button again, like this, a new story will come up on the screen and begin reading the next story. I will come by and pick up your completed test. When you are finished reading the next story simply press the mouse button, like this, and the screen will go black again. Raise your hand again and I will give you 1 paper with 6 multiple-choice questions on it. Keep doing this until you have read all three stories. When you have read all three stories and completed all three test, raise your hand and I will tell you what to do next.

You will also read three different stories from pieces of paper. We will follow a similar procedure. I will give you a paper with a story to read and you simply begin reading it when told to begin. When you have read the story, turn it over and raise your hand. I will then pickup your story and give you 1 page with 6 multiple-choice
questions on it. Begin doing the test as soon as I give it to you. When you are finished completing the test, raise your hand and I will pick it up and give you the next story to read. Begin the new story as soon as you are ready to do so. When you are finished, follow the same process. Turn it over, and raise your hand. I will pick up the story and give you another paper with 6 multiple-choice questions on it. Keep doing this until you have read three stories and completed three tests.

After you have read all six stories, three from the laptop computer and three from paper, and have completed all six tests, I will give you a short vocabulary test. Read each vocabulary word and circle the meaning that is closest to the meaning from the six stories you have read. When you are finished with the vocabulary test, raise your hand and I will pick it up. Then you may go over to the other side of the room and sit at the big table and I will tell you what to do next. Any questions?
Appendix F

Site Approval Letters
To: Human Subjects Institutional Review Board, Western Michigan University

From: Gerald W. Burke, Principal

Subject: Research Project on Reading Comprehension

Date: November 9, 1999

I have reviewed Jeffrey Conklin's Research Proposal on Reading Comprehension and am aware of the purpose and procedures involved in his study. I support this project and give Jeffrey permission to conduct this research at Dougherty Middle School.
December 2, 1999

Dr. Jeffrey T. Conklin
Assistant Professor
Department of Curriculum & Instruction
Albany State University
504 College Drive
Albany, Georgia 31705

Dear Dr. Conklin:

In response to your request of December 1, 1999, permission is granted to conduct a research project at Dougherty Middle School. As stated in your letter, please ensure that parental consent has been secured for each student assessed. Additionally, the confidentiality of all student information is expected.

If I can be of further assistance, please do not hesitate to contact me at 430-1313.

Sincerely,

Seaborn Jackson, Director
Exceptional Students Program
Appendix G

Subject Data Worksheet
Student Data Collection Sheet

1. Code #

2. Age ___ yrs. ____ months

3. Grade or Placement __________

4. Reading level ___________ as measured by the ITBS on _____/____/____

7. Student classification:
   a. ____ General Education Student
   b. ____ Special Education Student ________________ Label
   c. ____ Special Reading Assistance ________________ Program
   d. ____ Other Explain ____________________________

Comments: .

Student Performance Evaluation:

Passage 1: ___ Computer Presented   ___ Paper Presented   ___ Number Correct
Passage 2: ___ Computer Presented   ___ Paper Presented   ___ Number Correct
Passage 3: ___ Computer Presented   ___ Paper Presented   ___ Number Correct
Passage 4: ___ Computer Presented   ___ Paper Presented   ___ Number Correct
Passage 5: ___ Computer Presented   ___ Paper Presented   ___ Number Correct
Passage 6: ___ Computer Presented   ___ Paper Presented   ___ Number Correct

Vocabulary Test Scores ___ Computer Passages   ___ Paper Passages ___ Total
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