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A Computer/Tutorial System Compared With a Workbook/Tutorial Systeg for Presenting Instructional Material to At-Risk Elementary School Students

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A COMPUTER/TUTORIAL SYSTEM COMPARED WITH A WORKBOOK/TUTORIAL SYSTEM FOR PRESENTING INSTRUCTIONAL MATERIAL TO AT-RISK ELEMENTARY SCHOOL STUDENTS

by

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A COMPUTER/TUTORIAL SYSTEM COMPARED WITH A WORKBOOK/TUTORIAL SYSTEM FOR PRESENTING INSTRUCTIONAL MATERIAL TO AT-RISK ELEMENTARY SCHOOL STUDENTS

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Two different ways of presenting instructional material and reacting to students' responses were compared. One, taking advantage of several features of multimedia instruction involved a desktop computer and various computer-presented consequences of correct and incorrect responses (largely chosen by the student). The other consisted in presenting the same instructional materials (the SRA primary curriculum) in a workbook form with tutors' comments and praise as the main form of response consequence. The two methods were compared with respect to various measures of student and system performance, including student accuracy (percent correct responses), types of errors, amount of correct response repetition (over-responding), rate of trial completion, percent of correct responses followed by a reward (reward accuracy), and others. The computer-managed system resulted in higher percent of correct responses, elimination of over-responding, and a considerable increase in reward accuracy.

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Out of the night that covers me,
Black as the Pit from pole to pole,
I thank whatever gods may be
For my unconquerable soul.

In the fell clutch of circumstance,
I have not winced nor cried aloud;
Under the bludgeonings of chance
My head is bloody, but unbowed.

Beyond this place of wrath and tears
Looms but the Horror of the shade,
And yet the menace of the years,
Finds and shall find me unafraid.

It matters not how strait the gate,
How charged with punishments the scroll
I am the master of my fate.
I am the captain of my soul.

Invictus-by William Ernest Hensley.
(Felleman, 1936, p. 73)

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Finally, I dedicate this dissertation to the memories of those whose lives have passed: Todd Ozier, Demita Jones, Brad Brown, Clarence McFerrin, and Walter Bizzell. I dedicate this dissertation, with a prayer of hope, to those whose lives have just begun- especially, my nephew, James Hooker, and my daughter, Olivia Joi Hodge.

Vincent O. Hodge

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CHAPTER I

INTRODUCTION

Historical Background of Problem

> Imagine, not being able to make sense of the reading assignment your classmates have quickly finished. Imagine not being able to spell even simple, familiar words ... reversing the order of letters and numbers ... having lots of ideas to share, but not being able to organize them ... knowing the answer, but not having the confidence to speak up in class ... being bright, but feeling dumb. (Inman, 1990-91, p. 26)

Inman, in the above article, pointed out what many people have come to realize. For various reasons, a great number of young people have difficulty learning in a traditional classroom setting. This situation has added to the current crisis in our public education system because, regardless of the nature or level of the difficulties experienced by individuals, it is the responsibility of our educational system to educate all students. Therein lies the problem—how do we accomplish the task of efficiently and effectively educating students for whom traditional approaches have failed? This is a pressing issue for our society. Professional literature is replete with examples of traditional teaching methodology falling short of ideal accomplishments (Catello & Peck, 1990). In light of this, educators are being pressed to identify and pursue other options of effectively educating all students; including those most at risk of failure (Wepner, 1990-91). This emphasis was brought out by Sherwood (1990) who maintained that despite the fact that our educational system has always had students at risk of failure, public concern and media attention have contributed to our awareness.

Hornbeck (1990) noted that in addition to educational methodology, "there are a multitude of academic and nonacademic, economic, physical, and demographic conditions that place our children in the failure category" (p. 1). Wells (1990) reports that in 1985, the Education Commission of the States listed three categories of youth at risk of dropping out/failing: the estranged, the disadvantaged and alienated, and the deprived. Estranged students, according to Wells, are frequently seen as uninterested in or dissatisfied with the academic values "imposed" on them. They come from urban, rural, and suburban environments. The second group (i.e., disadvantaged and alienated) exhibits behaviors such as isolation, withdrawal, etc. as well as a lack of basic social and academic skills resulting in low self-esteem (i.e., self-report). The final group, although they may have family support and motivation to succeed, may suffer from effects of economic deprivation and racial discrimination.

Defining the Term "At Risk"

"At risk" has generally been used to describe children who are below the "norm" in social, academic, or economic conditions. It is only appropriate to issue a caveat regarding a definition that relies on the "norm" as a defining criterion. Technically, the norm of a particular (e.g., academic) population consists of "individuals with average scores...defined as normal, and individuals who show extreme deviation from average...defined as abnormal" (Gravetter & Wallnau, 1985, p. 179). For example, the norm performance in the typical classroom may be considered to be at the "C" grade level of academic performance. Clearly, several students will be performing at or below the classroom norm, when compared to their academic peers. An equal consideration is when the norm of a particular population lies above, or below, the standardized norm established by a much larger population (e.g., accelerated or less accelerated classroom settings). In such instances, being above the norm may imply only average performance among high scoring students, or conversely, being above the norm may imply exceptional (yet inadequate) performance relative to one's peers. Additionally, describing students as being below the norm (or defining the average performance) may entail some degree of subjectivity on the part of those using such categorizations. Table 1, although not all inclusive, provides a general visual summary of the "at risk" student characteristic/profile.

Table 1

At Risk Student Characteristics/Profile

SOCIAL	ACADEMIC	ECONOMIC	INTER-PERSONAL	BEHAVIOR
Teen parent	Failing 1+ courses	Unemployed	Abrasive/ Abusive	Depressed/ withdrawn
Single parent home	Grade Retention(s)	Welfare recipient	Poor peer relations	Violent
Inadequate support systems.	Learning disability	Major source of family support	Inappro-priate peer relations.	Suicidal/ S.I.B.
Poor modeling	Title 1	Illegal source of income	Refuses/ lacking authority figure	Negative self-talk/image
Minority status	Lacking standard proficiency	************	Negative self-talk/image	Disruptive/ impulsive

Subsequently, for some students, many of their "school experiences are characterized by an unrelenting history of failure" (Wepner, 1990-91, p. 265). The two most obvious forms of school related indicators used to determine that a child is at risk are poor academic achievement and behavior problems in school (Wells, 1990). Wells further states that poor academic performance is consistently and most reliably determined using the student's grades, test scores, and grade level(s) retention. Additionally, she points out that failure in more than one school, lack of basic academic skills, and verbal deficits are also considered. Students placed in this "failure" group are described as frequently exhibiting what is termed a "lack of motivation", poor time on task, and little class participation. Most of these children are below average academically and in need of learner intensive instruction.

It appears to matter not that the child may be bored or under-stimulated in the traditional classroom environment. Many times, the student (and/or home life) is identified as the source of the learning difficulty. By assigning the student's difficulty in the classroom to sources beyond immediate control, educators may be insulating themselves from the responsibility of teaching the most difficult students. By adopting this perspective the type and quality of instruction may be neglected as important determining variables of academic success or failure. By shifting the focus of teaching back to the delivery of effective instruction and to student development, educators can consider educational alternatives that are within the realm of the classroom.

CHAPTER II

REVIEW OF RELATED LITERATURE

The Use of Technology in Education

The purpose of this review is threefold: First, several key varieties of computerized educational technology are described, and the empirical support for the claims that are made for its benefits are evaluated. Second, the key characteristics of multimedia as an instructional technology are summarized, (e.g., learner control, immediate feedback, audio/visual modeling and imagery, objective presentation, and non-linear format, etc.). Finally, the adequacy of existing research on this instructional technology was evaluated while establishing the framework for the empirical investigation described at the end of the review.

Emergence of Computer Assisted Instruction

One technology option that educators have explored for general use in education is computer assisted instruction (CAI). CAI may be considered the technological successor of the traditional teaching apparati of the 1920's, and the teaching machines developed by Skinner and Crowder in the 1950's (L. C. Chen, 1990-91). This technology is generally defined as the use of a computer for a one-sided (e.g., computer generated, non-interfacing) presentation of educational material. Proponents of this technology (e.g., Cattalo & Peck, 1990; Olson & Krendl, 1991) claim that it affords a time efficient and effective manner by which students may be educated. L. C. Chen (1990-91) indicates that since the early 1960's this method of instruction has become an important tool in teaching. L. C. Chen also reports that there are limitations to this technology, which will be elaborated in a later section of this paper. Additionally, if placed on a scale of interactivity (see Table 3, p. 11) CAI might be considered a level 2 medium, which allows computer directed input to be affected by limited consequences; while truly interactive multimedia formats might be considered level 3 to 5 media, which allow for multiple responses and afford an equally multiple number of consequences. This shortfall is coupled with the limitations described later.

Interactive multimedia (IMM) instruction appears to be a viable alternative to CAI. This new and innovative technology has many of the features of traditional CAI (e.g., individualized pacing, relative degree of branching, immediate feedback contingencies) as reported by L. C. Chen (1990-91). But, IMM has other notable characteristics (e.g., audio/visual stimulation, environment manipulation, and interactivity) which may prove to be more effective learning vehicles (Bailo & Sivin, 1989; Wepner, 1990-91). Such a technology has untapped potential in the field of education. L. C. Chen (1990-91) indicates that "a growing body of research indicates that this...technology will create a powerful learning system which holds great potential for education in a variety of subject areas and for various types of learners" (p. 7). When applied to an already existing educational system (e.g., direct instruction, and other traditional methods), the quality and effectiveness of that method can only be enhanced.

Emergence of Computer Multimedia

The term "multimedia" is basically a generic term which refers to "any combination of two or more media formats that are integrated to form an informative and instructional program" (Heinich, 1993, p. 252). As the name implies, interactive multimedia allow students to respond, and have responses differentially effected by contingencies.

Computer multimedia technology differs from CAI in that it employs a combination of the video disc animation and sound capabilities of our present computer technology in a dynamic and vivid manner, while allowing the learner to affect and be affected by input to that system. CAI, on the other hand, primarily consists of a static display of textual images to which the student is allowed tightly restricted input. Further elaboration on these characteristics of multimedia instructional technology, and evidence for its efficacy, are provided in a later section. At this point, it should simply be noted that there is existing evidence to suggest that the quality and efficacy of instruction are improved through the use of computer multimedia technology. Data suggest that much of the promise held by this new technology is real and more than just another educational fad.

As previously indicated, the computer revolution has arrived in the classroom, spurred by the computer's advantages of cost and time efficiency. To help illustrate this point, consider the amount of information that is presently available on computer usage in the classroom compared to 10 years ago. Heinich (1993) reports that the amount of information available to him in 1982 comprised a small chapter in the first edition of his book on instructional media. In 1993, he allotted all or most of seven chapters to information on the use of computers in education and training. Presently there are entire sections of libraries dedicated to books dealing with the use of this new technology in education. Heinich also noted that what was once referred to as the potential of computers to control media image presentations is now an actuality. He states that "today the computer is the central device for orchestrating interactive multimedia programs incorporating still and motion images with print, graphics and sound" (p. v).

The multimedia packages of today have come a long way from the teaching machines from which they evolved and have greatly enhanced the computer-assisted instructional approach to education. Most educators are familiar with the concept of computer-assisted instruction, but may lack detailed definitions and knowledge of the principles inherent in the new (multimedia) technology. There are distinct differences between the various technologies frequently referred to as multimedia, interactive multimedia, and computer multimedia. The technology referred to in this document is defined by providing a concise description of what it is and is not. Distinctions are based on key characteristics of the technologies and are provided in contrast to that of computer-assisted instruction found in previous generations of educational technology.

Interactive Multimedia

The term "interactive" is basically a description of the capacity for computer technology to accommodate multiple response options effectively (i.e., tangential concept formation and non-linear logic/serendipity). Multimedia programs may consist only of audiovisual media, while interactive multimedia incorporate computers as a medium between programmed images and the user. The essence of multimedia programs is that they generally integrate multiple media into structured programs in which "each element compliments the others so that the whole is greater than the sum of its parts" (Heinich, 1993, p. 252). In other words, every component of these media are combined to provide the dynamic and vivid real time sights/sounds that exceed previous technologies.

Heinich (1993) provides an excellent overview of the new technologies in instruction (e.g., interactive and multimedia). He supports the claim that multimedia describe early attempts to combine various still and motion media, as well as live demonstrations to increase the learners' experience. The technology is based on the notion that a wide variety of media and experiences, when correlated with educational material, overlap and enhance the value of each other (i.e., the cross media approach to instruction). Heinich states that then, as now, system designers understood that learners respond differently to various information sources and instructional methods; a perspective of learning that is very consistent with the multiple intelligence theories described by Armstrong (1994), and employed by Ester (1994-95) as summarized in Table 2 on the next page. Therefore, one might infer that the chances of affecting the learner are increased when a wide variety of images, etc., are used. The multimedia system basically attempts to stimulate the multi-sensory, dynamic, real life experiences of the learner.

By definition, the term "multimedia" includes systems ranging from sound slides to computer media. The following descriptions distinguish between the various multimedia systems discussed. Note that the first three (1-3) forms of multimedia cannot be considered interactive, and are not the focus of this study. They are provided only for illustrative purposes. Also, it should be noted that the remaining three (4-6) forms of multimedia are considered interactive, in that they allow the learner to make multiple responses which affect and are affected by a computer system. The key element in defining interactivity is that the learner can make any number of inputs to the system, which are affected by the output of the computer itself.

Confusion may occur when attempting to distinguish between the various media technologies. This may be a matter of nomenclature as concepts consistent with a specific technology may be labeled differently across individuals and settings. For example, the technology that many lay persons describe as interactive multimedia is perceived by the author to be consistent with the interactive video and computer multimedia systems. Heinich (1993) and L. L. Chen (1994-95) provide good synopses of this concept as shown in Table 3 two pages over.

Table 2

Multiple Intelligence Theory Summary

Intelligence	Attribute	Neurological System	Development/ Emergence
Linguistic	Sensitive to sounds and language	Left temporal and frontal lobes.	Rapid in early childhood through old age.
Mathematical	Capacity to discern numerical patterns and long lines of logic.	Left parietal lobes, right hemisphere.	Adolescence and early adulthood.
Spatial	Visual-spatial acuity, and manipulations.	Posterior right hemisphere.	Topological until age 9-10.
Kinesthetic	Ability to sense ones body movements, and control objects skillfully.	Cerebellum, basil ganglia, motor cortex.	Varies according to component, and/or domain.
Musical	Ability to produce rhythms etc., and strong musical appreciation.	Right temporal lobe.	Earliest to develop.
Interpersonal	Discerns moods and behaviors of others.	Frontal lobes, temporal lobe, limbic system.	First 3 years is critical for bonding.
Intrapersonal	Strong sense of self awareness	Frontal/parietal lobes, Limbic system.	Boundary formation critical in first 3 years.

Note. The above table is from Multiple Intelligences in the Classroom (pp. 6-8), by Thomas Armstrong, 1994, Alexandria, VA: Association for Supervision and Curriculum Development. Copyright 1994 by the ASCD. Adapted with permission. All rights reserved.

While interactive to some extent, the computer hypermedia system is more of a database of information with directions to guide the user to specific information; and tools for manipulating that information. The end product of computer hypermedia is developed by the learner/user, whereas interactive video is used more for tutorials, and programmed instruction. In an effort to avoid confusing nomenclature, the media labels used in this document will be consistent with the definitions and descriptions presented above.

Table 3

Levels of Multimedia Instructional Technology

1. Sound slide sets are presented as still images, combined with voice/ music, which only allow the learner to view them without any degree of interactivity.
2. Multi-image presentations consist of two or more still and motion images, which are presented simultaneously and combined with music/voice, also do not afford the learner interaction with the presented stimuli.
3. Multimedia kits consist of text, pictures, or real objects. These items are handled/manipulated by the learner, who may discuss them in small groups.
4. Interactive video consists of still and motion images, computer text, and graphics, combined with voice/music; which allow multiple responses by the viewer to be affected by visual/auditory feedback and correction.
5. Computer multimedia present the learner with computer text and graphics, still and motion images, which are combined with voice/music. These media also allow multiple (choice) responses, control of sequences, as well as editing, synthesis of material, and automated data collection.
6. Computer hypermedia are computer texts and graphics, and still/ motion images combined with music/voice. These media allow the learner to create text by making links among verbal, visual and audio information sources.

Note. This table is from Instructional Media: and the New Technologies of Instruction Fourth Edition (p. 243), by Robert Heinich, 1993, New York: Macmillan. Copyright 1993 by Macmillan Publishing. Adapted with permission. All rights reserved.

Potential Uses of Multimedia in Education

Technological developments of the past few years have occurred with increased frequency in education. The media most frequently used in educational settings involve interactive video to teach social skills or traditional learning material (e.g., L. C. Chen, 1990-91; L. L. Chen, 1994-95; Mortorello, 1989; Welch & Jensen, 1990). L. L. Chen (1994-95) reports that since 1977, when the first video disc program was produced, there has been growing enthusiasm for interactive video technology applications. Unfortunately, when one considers the comparison to the applications in the areas of training, database, etc. there really is not a great deal of application being made in the educational arena. There is, on the other hand, a growing body of research indicating that multimedia provide a powerful learning system that holds unrealized potential in educational applications to a variety of learners and subject areas (e.g., Bahr, 1991; Christie and Sahers, 1989; Gay and Mazur, 1989; Heller, 1990; Wepner, 1990-91).

It is possible that many educators are leery of new technology, based on the development of educational fads that have proven to be less than effective. Fortunately, there continues to be community and national pressure to employ new technologies in the classroom (i.e., President Clinton's Goals 2000- Educate America Act). As Naron and Estes (1986) indicate,

> The new...technologies are not just another passing educational fad. Unlike programmed instruction of the 1960's or similar failed trends, the new...technologies have permeated all walks of life. Using technology in education is not just a new way to teach concepts; it is an essential part of training students to be prepared for life after school (p. 31).

Given such reports, it appears that the primary efforts of educators and researchers may be better focused on the benefits and efficacy of this new technology when compared to the limitations of its predecessors(s).

Limitations of CAI

The potential for CAI and computer multimedia (CMM) applications in education appear to be limitless. But, as with all emerging technologies, limitations and functional concerns exist in the earliest developments. The same is true for CAI (and to some extent, CMM). Despite the description of early technological limits, the use of more advanced technologies has apparently overcome previous obstacles and enhanced the more functional aspects of this technology.

First, CAI is limited by a linear format in which a series of educational items (questions) are presented in a non-variable and predetermined sequence. This sequence cannot be altered, nor can digressions occur. The characteristic rigidity and constrictive nature of this format is due to its single line of logic (usually the programmer's). Given the nature of the linear format, students are forced into a learning and instructional path similar to the traditional methods that have directly or indirectly "failed" numerous students.

Second, CAI images are not presented as dynamic visual materials. Basically, these images are "freeze frame" presentations which do not match the potential of the moving/dynamic presentations of the learner's world.

The final limitation of CAI is what L. C. Chen (1990-91) describes as the "most important limitation of CAI programs...their heavy reliance upon verbal or abstract teaching" (p. 6). This format consists mostly of text, primarily relying on the verbal behavior of the learner, which may or may not be sophisticated enough to function in this format. Also, this format is extremely dependent on the description, interpretation, and verbal repertoire of the programmer. Many teaching methods involve the use of concepts that are presumed to be, but may not be part of the student's repertoire. By assuming that students process problem solving, or task oriented concepts , CAI programmers may deny students the opportunity to manipulate the environment in a way that allows them to actually learn. Instead, with CAI, students are forced to function in a potentially aversive/ frustrating, confusing, non-identifiable nor observable (i.e., mentalistic) environment.

Benefits of CAI and CMM

A substantial number of educators and researchers have claimed tremendous educational advantages and impressive success for computer-based educational technology. For example, Olsen and Krendl (1990-91) investigated the effects of using microcomputers (micros) to instruct at risk children. Although there are some studies that provide questionable data, Olsen and Krendl report that the use of micros did enhance the performance of students. They report that "students stated that the biggest advantage of using microcomputers was the ability to control the pace of their learning" (p. 169). As a result of their efforts, Olsen and Krendl conclude that, at the time of their study, existing research on CAI applications provided "a picture of instructional success" (p. 173). Diessner, Rouscoulp, and Walker (1985) showed a 51% increase in English tests, mastery of 91% of material, and an increased "interest" in writing and revising papers in subjects using this technology.

Hanley (1985) provides an excellent synopsis of research on the benefits of computers as instructional aids. He and others (see below) provide information to support claims that CAI is more effective than traditional instruction alone, given a match between the student's "learning style" and instructional method (Ester, 1994-95); that this method of instruction is an effective supplement to elementary level instruction (Jamison, Suppes, and Wells, 1974); that students are less distracted and attend more to computer generated learning materials (Calvert, 1993-94); that this approach may be a reasonable replacement for traditional instruction at the secondary and college levels; and can possibly lead to time and cost savings (Jamison et al., 1974). It is important to mention that computer assisted instruction has been demonstrated to be effective as a supplement to traditional instruction, but when CAI has been investigated as a replacement for traditional instruction the overall results were what Hanley (1985) describes as "... equivocal, about half the studies showed gains for CAI, half showed advantages for traditional instruction, or no difference." (Hanley, 1985, p. 260).

In the late 1970's meta-analysis was introduced as a method used to quantify the effectiveness of the new technology (e.g., Glass, McGaw, & Smith, 1981; Hartely, 1977; Kulik, Bangert, & Williams, 1983). Each of these reviews provides favorable results for CAI, when compared to other methods of instruction. For example, the size of effects for gains in student achievement ranged from .1 to .45 standard deviations.

In another study, Kulik (1983) investigated the results of 48 studies; using the results of final exams. Kulik indicates that

> The students who received CAI outperformed students who had received only conventional instruction in 81% (39) of the cases. The average effect size was .32 standard deviations, placing the CAI students in the 63rd percentile...in comparison to a 50th percentile for students who received traditional instruction. (p. 19)

As a result, this material is used to support the claims of educators as to the effectiveness of this new technology (e.g., Bear, 1984).

In one of the 48 studies reviewed by Kulik, students who received conventional instruction actually faired better on final exams. Also, even though the effect of CAI appeared moderate (e.g., .32 standard deviations), the averaged effect actually masked a range of scores between a negative level of .75 standard deviations, to a positive level of 1.75 standard deviations. Based on these and similar findings, one might conclude that instructional technology may best be used as a supplement to traditional instruction.

Learning Through Multimedia Instructional Technology

There has been a great deal of enthusiasm for the potential application of multimedia instructional technology (MMIT) as a supplement to traditional instruction. On the whole, this enthusiasm appears to be well founded—data generally show that this instructional format is relatively effective. However, without further discrete measures of the user's behavior, the technology cannot be separated from the characteristics inherent in this learning/ instructional vehicle; namely: (a) objective presentation and evaluation, (b) a nonlinear format, (c) learner control, (d) immediate feedback, and (e) audiovisual modeling and imagery.

Upon initial exposure to these characteristics, one might be tempted to attribute any derived learning effects directly to the computer. Such erroneous credits are not uncommon, and tend to lead to an overall misconception of MMIT as a panacea for one's learning ills. Additionally, erroneous conclusions tend to obscure two of the more critical issues surrounding CAI (in general): (1) the investigation of elementary learning principles, as effected through the use of computers; and (2) the role of the computer as it is used for the delivery of instruction. The key construct, from which the remainder of this chapter will be derived, is that CMM is a vehicle through which principles of instruction, learned in the laboratory, can be replicated in the educational setting. By focusing on the elementary learning principles and the computer's role in this instructional technology, we shall provide some insight into learning principles that underlie the effectiveness of its characteristics.

Learning, as acknowledged by Poling, Schlinger, Starin and Blakely (1990), is considered "relatively permanent changes in behavior due to experience" (p. 127). One of the assumptions of much learning research is that by coming to understand the learning process, one will be able to develop more effective behavior-change technologies. When viewed from this perspective, CMM may be considered as such a technology. In an effort to help arrive at a similar conclusion about learning through multimedia as an instructional technology, one must elucidate the learning process, its underlying laws and principles, and how they emerge through the instructional medium. A detailed extrapolation is beyond the scope of this document. None the less, a brief overview of the above considerations is provided below.

Learning through multimedia is supported by several authors (e.g., L. C. Chen 1990-91; L. L. Chen, 1994-95; Hanley 1985; Heinich 1993); each of whom has provided fine proof of this process. Next, we will discuss those aspects of MMIT (i.e., CMM) that may occasion learning.

The Technology as a Learning Tool

The objective presentation of material and evaluation of learner responses is a facet of MMIT that enhances its effectiveness as a learning vehicle. This technology can effectively and efficiently provide the controls desperately needed in educational research, yet it is this aspect of the technology that may be frequently overlooked. Olsen and Krendl (1991-92) suggest that many of the measures used by educational researchers tend to rely on subjective assessments, which may be confounded by the beliefs and attention of the investigator/teacher. In this situation, there is no guarantee that the learner is attending to material, the novelty of the technological phenomenon, or the attention of those she/he is reporting to. By relying on the uncontaminated presentation of material and contingencies, as well as the tightly controlled and objective measures provided through automatic data collection, researchers and educators can more accurately identify discrete trends in learner performance and provide empirical support for the use of this technology in the classroom.

The non-linear format of CMM is a characteristic that lends to the computer's flexibility as an instructional vehicle (material can be obtained, generated, and presented in more than one format), In addition to the experience of learning. L. C. Chen (1990-91) suggests that the nonlinear format of MMIT content entails "allowing the learner to choose various paths through the program based on individual instructional needs" (p. 9). This aspect of CMM facilitates choice and learner control (discussed below), in that the learner is allowed to select the manner in which material is presented. Additionally, from a more educational perspective, the learner receives training in specific weaknesses until a set criterion is achieved. By repeatedly exposing the learner to difficult or unfamiliar material, a new (functional) repertoire is developed and learning occurs.

Learner control is described as the opportunity afforded the user to direct his/her instructional path. Basically, it entails allowing the learner to emit responses that affect the instructional material, which result in the contingent reinforcement of those responses. For example, a student may be allowed to select a specific context in which material is presented, the pace at which it is presented, and any digressions or terminations that can occur during an instructional period. A closely related aspect of learner control is choice of reinforcer type, a key characteristic of CMM and a concept which may provide empirical evidence of the technology's effects on learning.

Behavioral researchers have been interested in the concept of choice and learning for years; both in terms of "(1) how preferences develop, and (2) how existing preferences influence learning" (Rachlin, 1976, p. 547). From such research, we can assert that allowing learners to make choices in educational settings (be it choice in material, presentation, assignment, or reinforcement), will result in a positive learning effect. Several authors (e.g., Fantino and Logan, 1979; Green and Synderman, 1980; Glynn, 1977; Houghton, Bronicki, & Guess, 1987; Navarick, 1982, 1986; Rachlin, 1976; Rachlin, Logue, Gibbon, and Frankel, 1986) have reviewed and investigated the "choice" phenomenon, and provide ample support/evidence of the effect of choice on the learning process.

The immediate feedback (i.e., correction, remediation, reinforcement, etc.) afforded the learner through this technology is a very critical component of the learning process. The temporal contiguity between response and consequence form the foundation of our most basic learning principles. Skinner (1953) provides an excellent explanation of the role of temporal contiguity in learning and maintaining responses. In essence, he states that the environment (i.e., the learning environment of CMM) is developed so that specific events tend to occur together. Additionally, the learner has evolved in such a way that his/her behavior changes when it comes into "contact" with such an environment. Please note that "learning" is the behavior of focus. Therefore, when stimulus events (i.e., words, images, sounds, reinforcers, corrections, etc.) contained in the (computer) environment are presented to the learner in the manner described above, there will be an effect on the learner; as long as these events occur close in time and in an orderly manner.

Given the above it is important that one be able to clearly distinguish between the processes of rapid correction and reinforcement. Rapid correction, as its name implies, is the immediate and rapid correction of errors. It is a procedure in which stimulus presentation is contingent on the occurrence of undesired behavior. Upon correction, the probability of the incorrect response occurring in the presence of the new stimulus is progressively decreased. An example of this process is employed by tutors in the Western Michigan University "Project Help" tutorial program. By using a direct-instruction methodology, learner's receive individualized instruction and immediate correction of identified errors. In the direct-instruction model, for example, the student is prompted by his/her tutor to respond to a visual stimulus. In this example, the student is required to emit the desired response and if the response emitted is not correct, then the student is immediately provided a correction procedure and asked to match the modeled correction (e.g., "no, Timmy the word is dog, What word?...Yes, dog...).

Reinforcement, on the other hand, is similar to correction in that it occurs in close temporal contiguity to the response, but it differs in that it occurs contingent on a correct response to a stimulus. Additionally, reinforcement entails the presentation of that contingent stimulus so that the future probability of the desired responses' occurrence in the presence of the discriminative stimulus is increased.

Audiovisual presentation is another feature of multimedia instructional technology that many educators find intriguing. Unlike the above items, there hasn't been an extensive investigation of the reinforcing value of this phenomenon. None the less, by the very nature of this technology, material has to be presented and responded to. Once material is presented, it effects the learners' receptors and evokes various responses, with some of which the learner may have a more extensive (mode specific) history of reinforcement. Such receptor/response mode effects are considered by many to reflect a type of "learning style bias" on the part of the learner (Griggs and Dunn, 1989; Sein and Robey, 1991). These authors report that such biases are specific to various populations of individuals, and that by presenting material in a manner which affects those learners' biases, one enhances their performance. Armstrong (1994), though not behavioral in orientation, presents a similar line of support in his work on multiple intelligences. If considered in terms of behavioral theory, it is acknowledged that individual learning differences (histories) do exist, and that such differences may be physiologically based. And it is plausible that individuals with distinctly different learning histories have been more effective in their preferred environments (e.g., homes, playgrounds, etc.) by responding to stimuli that are most salient in those settings. Therefore, by responding to such stimuli (i.e., traffic lights, video game arrays, a coach's whistle, etc.) in an effective manner, the probability of being affected by reinforcers is greatly enhanced and maintained. Given a high probability of generalization to similar stimuli across settings, such biases may very well exist. Even these apparently mentalistic constructs have a behavioral explanation, and should be viewed as objective events (as opposed to subjective preferences).

Purpose of the Present Study

There are many differences between a fully developed multimedia interactive system and a traditional educational system that affect the learner's behavior in the direction of more effective learning. The present study represents only a small step in the multimedia direction which isolates two of the features of MMIT, the way the instructional material is presented, and the nature and choice of the rewards that are contingent upon correct responding. Two different instructional systems were compared. One (referred to as the Computer system) involved a desktop computer for presenting the instructional materials and various computer-presented consequences of correct and incorrect responses (largely chosen by the student). A tutor was always present with the student and computer, and the tutor monitored the responses for correctness, and initiated the sequence of trials. The other (referred to as the Workbook system) consisted in presenting the same instructional materials (the SRA primary curriculum) in a Workbook form with the tutor monitoring the responses for correctness, initiating the sequence of trials, but with tutors' comments and praise as the main form of response consequence. The two instructional methods were compared with respect to various measures of student and system performance.

The fact that the noncomputer condition (based on the Direct Instruction approach) is individualized, largely self-paced, involves immediate feedback, and is based on relatively objective criteria, makes it a considerable improvement over ordinary classroom instruction. This permits the observation of any further benefits that can result from computer presentation of material plus computer based (multimedia) student-chosen rewards, with the other advantages (individualized, self-paced, etc.) held constant. Here the comparison is between a highly effective instructional system involving a well designed Workbook plus a tutor trained to manage the system, and a very similar system differing only in the way the instructional material is presented and the nature and choice of the rewards for correct responding.

Several authors have investigated CAI and CMM as instructional tools (e.g., Hasselbring et al., 1987-88; Jaspers & Ji-Ping, 1990-91; Jensen, 1991; Olsen and Krendl, 1990-91; Welch and Jensen, 1991; Wepner, 1990-91). Despite such extensive research of this emergent technology, Olsen and Krendl (1990-91) and Clark (1990) report that the majority of such research is flawed. Methodological flaws related to design, ambiguity, external validity and measurement seem to abound in the literature, in part because the research is usually conducted in real learning situations involving variables that are only partially under the control of the investigator. The present study is similarly subject to various methodological criticisms, but will possibly contribute some unique support for some limited aspects of the general multimedia approach.

CHAPTER III

METHOD

Subjects

Six students (all males) ranging in age from 7 to 9 years served as subjects in this investigation. All subjects were selected from those participating in a remedial education program at Western Michigan University (Project Help see below). All procedures followed in this investigation were approved by the Human Subjects Institutional Review Board (see Appendix A). In order to be selected, all students had to meet the following criteria: (a) considered at risk of failure in their regular school; (b) referred by school counselor, teacher, or parent; (c) academic skills pre-assessed; and (d) informed consent to participation obtained from parent and student (Appendix B). None of the subjects had any CMM history, although the majority were familiar with computers. All subjects had experience playing video games.

Setting

Sessions for the experimental group were held in a computer lab (approximately 10m by 15m) where the subjects attended an after-school tutorial program (Project Help) four times per week for sessions that averaged two hours in duration. Project Help is a long standing community service project sponsored by the School Psychology Program of Western Michigan University, Department of Psychology. The project is designed to provide corrective and remedial instruction in basic reading skills. Each 16-week program period is designed as a supplement to school-based and home-based instruction. Experimental sessions were prearranged to occur intermittently through the instructional curricula of Project Help.

Sessions for the 3 subjects in the control group were held, as is the practice in Project Help, anywhere in the building that the tutor and student could be relatively isolated from the ordinary university classroom activities. This was often in an empty room, sometimes in a hall, sometimes in a stair well, and so on.

Apparatus

The subjects in the control group, and the experimental subjects when in the baseline condition used an SRA Workbook appropriate to their instructional level . They sat with a tutor, who provided instruction, monitored the student's performance, provided correction and some social approval ("good job", "have you been practicing?", etc.). In the Computer condition at the onset of this investigation one Macintosh 2si Computer (Apple Corp.), with a minimum of 16 megabytes of memory (RAM) was used. The Central Processing Unit (CPU) of this computer was capable of supporting an external disk drive (Syquest 88 MB), an external CD-ROM (NEC 3x), as well as internal audio and video cards, which were used to generate multimedia images/sounds as reinforcers. The CPU was attached to a 15-inch color display monitor, standard mouse, and extended keyboard. During specified periods of this investigation (testing) only the mouse and two keys on the keyboard were operational. Three additional computers (similar in description to the above) were made available by the WMU Geology department midway through this investigation. At the conclusion of this investigation, four Macintosh 2si computers were being used.

Each computer was located on a desk (approximately 2m x 1m x 1m) which was situated in front of two chairs. Ambient illumination was provided by florescent ceiling bulbs. Though there was no masking sound provided, the room was isolated from external variables (e.g., nonessential personnel, distracting sounds, etc.). Additionally, programming of experimental events (see below) and data collection were controlled by the computers (see Appendixes C-D), each of which employed the System 7 operation software, "Hypercard" programming software, and "Quick-Time" media software produced by the Apple Macintosh Corporation. Examples of the events controlled by the computer were the presentation of a hypercard visual effect similar to a turning page; which was used to signal a changing stimulus array (i.e., to present a new trial), and the presentation of programmed rewards. Rewards were contained in four separate files for each of four distinct reward types, movies, sounds, pictures, and games.

The movie reward file contained seven sport video clips (e.g., NBA playoff highlights of the Chicago Bulls and New York Knicks, in addition to college football, baseball, track, and gymnastics) which were 30 seconds in duration. There were also ten cartoon clips which ranged from 20-60 seconds in duration available in this file.

The auditory (sound) reward file contained a total of 26 reward sounds that were frequently used by the project tutors (e.g., good job; have you been practicing; keep up the good work, etc.), and presented in the investigator's and other voices familiar to the students. Twenty additional sound clips were used, based on their popularity with students (e.g., cartoon character's voices; crowd applause/cheers; movie themes; and arcade sounds).

The picture reward file contained approximately six pictures of cartoon characters (e.g., Bugs Bunny), five drawings (e.g., a blue ribbon), and four photographs (e.g., two each of sports stars and animals).

The game file consisted of four games that were made available at the end of lessons and during breaks. A Space Invader type arcade game, a flight simulator game, a strategy puzzle and an educational exploration game were available when the student chose this option, however only one student chose such a game, and on only one occasion, so this option was essentially irrelevant. These students either had not had sufficient experience with this type of computer game, or the prospect of waiting until the end of the session for the reward made the option unattractive.

Additionally, a shareware library of sport clips, action sounds, popular events (e.g., spacewalk), and cartoon clips (e.g., Porky the Pig; Popeye, etc.) became available near the end of the experiment, but was not much used. Each of the above files could be accessed by the student's choice from a "menu" of items presented as hypercard buttons. The buttons were controlled by the computer, and presented only during the Computer phase of this investigation.

Procedure

Upon admission to Project help, all students were given a Woodcock inventory of reading readiness, as part of their intake and assessment interview. The Woodcock was used to determine the student's placement within the reading curriculum used in the project. It was also used to establish a measure of improvement in the standard pre-test/post-test comparisons used by the project staff.

At the time of this investigation the SRA curriculum used by the project consisted of four primary components: (1) letter identification; (2) word decoding; (3) reading comprehension; and (4) math strategies. In the letter identification phase of the curriculum, students were shown a letter and given a model of the letter sound. Following the presentation of visual and auditory stimuli, the student was prompted to make the sound in the presence of the visual stimulus (letter). For example, upon presentation of the letter 'a' the student was informed that " this is the letter 'a'. The letter 'a" makes the sound aaaaa, as in cat. Now you try..." At this time the student makes the letter sound that has been associated with the letter "a". This sequence was repeated for all consonants and vowel sounds in the alphabet. Students did not proceed further until they performed at 100% accuracy .

Students placed in the decoding level of this curriculum were trained to use the letter discrimination repertoire developed in the previous phase to isolate the individual letter sounds of words. This word-attack strategy was then used to combine letter sounds in a successive approximation to the desired word. An example of this level of instruction/tutoring was the students decoding and eventually reading the compound stimulus array "K-I-N-G". Upon presentation of this array, the student was instructed to "sound out" each of the letters in the word, and then to "say it fast" for a complete pronunciation of the word. More specifically, upon presentation of this array the student was told that "we are going to read a word that you know. The letter sounds are familiar, and we will combine them to make a new word. First I want you to sound it out..", at which time the tutor pointed to each letter of the word to ensure proper letter discrimination (pausing 1-2 seconds per letter). Given a correct letter discrimination-identification and an immediate verbal reward (in the baseline or control condition), or a computer-generated reward (in the Computer condition) the tutor then informed the student that "now we are going to combine the letters." Following this instruction, the tutor pointed to the first letter of the array "KING" and dragged his /her pointer beneath each letter in a fluid motion, so as not to cause an inadvertent pause or signal error. At this prompt, the student is supposed to blend the letter sounds together. Finally, at the prompt "say it fast", the tutor signaled the student to pronounce the word. The student then immediately read and said the word "KING." All attempts are immediately followed by an appropriate reward. This phase of the decoding component is considered preliminary to other phrases of this curriculum; which is divided into progressively more difficult words and eventually sentences and paragraphs (e.g., decoding A and B, and comprehension).

In the comprehension component of the curriculum, students were asked to read a passage that ranged in length from a few words (e.g., 'the dog had black fur'-

decoding 'A'), to much lengthier paragraphs (e.g., short stories used in decoding 'B'). Following the reading, the student was asked questions about what was read (e.g., what color was the dog's fur?). Immediately following the response, the student was presented an appropriate consequence (i.e., verbal praise, or computer generated reward. For instance, the student was provided a reward similar to that provided in the earlier training if the response was correct. If the response was incorrect, the student was lead back to the passage that contained the correct information and asked to find the correct answer. (Although mathematics was a part of the SRA curriculum used in Project Help, it was not the focus of this investigation and will not be included in this section of the dissertation.)

Following the Woodcock assessment used to determine existing reading ability all subjects began their participation in the ordinary Project Help after-school remedial educational sessions. At various times during the next four months, in addition to their regular Project Help sessions, three of the subjects (the Experimental Group) were exposed to a small number of sessions using the Computer and Probe procedures. The other three subjects were considered the Control Group. A random selection the experimental subjects' regular Project Help sessions were designated "baseline" sessions for those subjects, and a random selection of the control subjects' regular sessions were analyzed as control data. For the three control subjects, C1, C2, and C3, data were obtained for 7, 5, and 8 sessions respectively.

In the Project Help procedure, tutors were instructed to provide vocal verbal feedback for all student responses, but from the tapes of the sessions it appears that the proportion of correct responses followed by an audible (from the tapes) form of verbal praise varied from less than 10% to as high as 70% (see column 13 of Table 4-7 in the Results chapter). Students could also earn points toward special activities intermittently scheduled during the course of the semester (e.g., bowling, trip to video arcade, pizza party).

For the experimental subjects, E1, E2, and E3, baseline data were obtained from 8, 9, and 8 sessions respectively, during which standard rewards and corrections were provided for responses. The Computer component of the procedure for the experimental subjects differed from baseline by presentation of material on the computer, and allowing subjects to choose the type of reward presented for correct responses (i.e., sound, video, picture, game); as well as whether they would like to work in the text or on the computer (none of the experimental subjects ever chose the Workbook when they had an opportunity to work on the computer). Subject E1, E2, and E3 had 3, 4, and 4 Computer sessions respectively. The computer text work was identical to the material presented in the standard SRA text.

In the Computer condition, an attention response was required to begin each sequence of exercises. The attention response, which occurred at the beginning of each trial, consisted of two types. An initial attentional stimulus was presented on the screen and required the student to type his/her name. This prompt was set to activate the session clock. For example, once the tutor identified the chapter and exercises to be completed, the screen prompted the student to "please type in your name." A running timer was activated upon depression of the return key. All other attentional stimuli, asked the student to select the preferred reward by directing the pointer (computer icon) to that choice and clicking the mouse (hypercard buttons were associated with each choice option and accessed files containing the rewards described in the apparatus section). Upon each response, the timer began and data collection programs became operative. Correct and incorrect responses were tabulated by the tutors by a stroke of the F7 and F8 keys. The mouse was operable only between trials as a mechanism for attention responses to proceed to succeeding trials. All other keys and manipulations were ineffective at times not described above.

As with the text-bound presentation of tutorial material, responses to computer text were monitored by the tutors for accuracy. F7 keystrokes resulted in a frozen screen and a prompt by the tutor to correct a detected error. F8 keystrokes resulted in a reward presentation and progression to the next trial (card) on the computer. Approximately 70% of all correct responses were rewarded on a random schedule of reinforcement. Of the rewards provided, approximately 90% were those chosen by the student. The remainder of reward presentations (10%) were not selected by the student. Presentation of rewards and probability of their presentation were controlled by the computer to ensure the students' exposure to all reward types. This feature was added to increase the reliability of a true choice response.

Students were prompted to make a choice of reward following a correct response and reward presentation. On the occasions when the student responded correctly to the instructional material, but did not receive a reward presentation, the visual hypercard effect of a turning page was used to function as an indication that the response had been correct. Having been previously associated with progression through the instructional material and possible reward presentation, this array was intended to function as a reward for the student.

Given an incorrect response, the student was presented a frozen (non-changing) screen which was accompanied by an audible stimulus that was associated with errors (e.g., a computer-contained voice saying 'nice try'). In addition the student was informed by the tutor that the response was incorrect and to try again.

Examples of this procedure include the student's response to the letter array "D-O-G" at the decoding A level of word-attack training. After selecting the lesson desired, a running timer and data collection program was started upon the student's name entry (attention response). A hypercard effect similar to a turning page revealed the letters D-O-G. At the instruction of the tutor, the student was given the verbal prompt to "sound out" the letters in the word and then blend them without pause (e.g., 'say it fast'). Correct responses were identified by the tutor's depression of the F8 key, and resulted in a random presentation of rewards.

In an effort to control for the confound of not being exposed to the alternative reward types, approximately 10% of the rewards presented were not pre-determined by the student (i.e., forced choice). The probability of this type of reward was set to ensure response maintenance in subjects through a high degree of control over the type of reward delivered. In addition, this level of forced choice occurrence was chosen to lessen the chance that responses would extinguish due to the subject's not having the choice of reward presented. Finally, the investigator relied on the reward value of the hypercard effect of a turning page to serve as a mediating reward stimulus to maintain responses in this condition.

If, while in the presence of the stimulus array D-O-G, the student made an incorrect response (e.g., paused between letters; said CAT; or responded with a latency of more than 5 seconds) the tutor depressed the F7 key to indicate an incorrect response. As a result the timer continued running, and there was no screen change (i.e., turning page). In addition, the computer presented the student an audible error signal; while the tutor provided correction.

A randomly selected session occurring after the first Computer session was selected as a Probe condition which was similar to the Computer condition except that subjects were not provided computer-generated reinforcement. This condition was employed in an effort to assess any potential novelty effect of using computers to present the reading curriculum. Unfortunately Probe session data were only available for subjects E2 and E3.

All conditions required that the tutor and student sit with the instructional material between them. The text material used in baseline conditions was situated on the table in front of the student, and the tutor was seated to the immediate right of the student. Computer contained text was presented on the computer screen, with the student seated directly in front of the screen and the tutor seated to the proximal right of the screen. The computer keyboard was situated directly in front of the tutor; while the "mouse" and pad were located on the table directly beneath the screen, and in front of the student.

The tutor read all instructions and monitored responding for immediate appropriate feedback. Incorrect responses consisted of incomplete responses, mispronunciations, starts/stops (e.g., starting a word, saying part of it, stopping, and starting the word again), and response latency greater that five seconds. Correct responses were recorded when the student made a complete and clear utterance with a response latency of less that five seconds. It is important to note here that in the noncomputer condition, the tutor had to record the student's responses on a special data sheet, but with the computer this record was kept automatically by the computer and all the tutor had to do was enter the appropriate key stroke on the computer.

Sessions began with a review of the previous day's session and continued from the point at which the student's session had ended on the previous day. All exercises occurred in sequential order, as did trials and sessions. Occasionally, students were directed to earlier lesson(s) in this sequence to revisit training/material that was currently causing difficulty in later baseline or control session(s) This potential pre-learning confound was controlled for in the Computer component of this investigation. It was possible for text work to be continued from the previous day, before the experimental data were collected. In such instances, if a predominant number of exercises were completed (e.g., more than 50%), or if at least 40 minutes were spent in the baseline condition, the data were collected and included in the baseline average. This practice occurred in order to accommodate the varying response rates of students (e.g., relatively fast or slow responders). For example, one subject displayed a rate of responding in the pre-test reading and levels of redirects to task that indicated the potential for some sessions to exceed 2 hours in the completion of one lesson. On the other hand, another subject displayed rates of responding which indicated the potential for completing more than half of a lesson in less than 20 minutes. If the Computer component of this investigation preceded the student's return to text material, then sessions were recorded by tutors (and monitored for trends) but not included in the baseline data, in order to ensure the completion of baseline prior to a Computer component. Additionally, students were provided breaks from instruction, which generally occurred at the end of an exercise/trial sequence of approximately 40 minutes in duration. Session length (approximately 40 minutes) was determined by the amount and content of material, as well as the student's level of attention and rate of responding.

Dependent Variables

The variables measured during the investigation included: (a) session duration, (b) trials in the session, (c) number of correct responses, (d) number of errors, (e) types of errors, (f) number of over-responses (correct responses occurring after the first correct response to an item), and (g) number of rewards delivered during the session. The total number of Computer sessions for the Experimental subjects was determined by the student's placement within the project curriculum. One of the subjects (E1) did not complete the total experimental regimen due to temporary parental withdrawal and acceleration through the curriculum. The remaining subjects completed predetermined (randomly selected) lessons presented in the Computer and Probe (no choice) formats.

Data Collection

During this investigation, data were collected both manually and automatically. The number of exposures to trials and sessions varied across subjects and across conditions, and these data were tabulated during all conditions by tutors. Automatic data were collected during baseline and control conditions via tape recorder and by computer (see Appendix C) during Computer and Probe conditions. All data were collected continually during each session, and across conditions on a regular basis. Additionally, Project Help staff tabulated and plotted student progress at the end of each session (see Appendix E for the data collection procedure followed by tutors).

Experimental Design

The performance of the control subjects was compared with that of the experimental subjects during the sessions when the latter were using the computer (the Computer and Probe phases). This was a between-groups comparison, and group means as well as the data of individual subjects were compared, visually and with a standard statistical significance test. The performance of each experimental subject during the baseline condition (no computer use) was compared with his performance during the Computer and Probe conditions (computer used). This was a within-subject comparison, accomplished visually and using a standard statistical significance test.

CHAPTER IV

RESULTS

The primary purpose of this investigation was to compare two different ways of presenting instructional material and reacting to students' responses. One involved a desktop computer and computer-presented consequences of correct and incorrect responses (referred to as *Computer system* or just *Computer*) plus tutor monitoring of responses and initiating trials. The other consisted in presenting the same instructional materials in a workbook form with tutors' comments and praise as the main form of response consequence (referred to as the Workbook system). The two systems will be compared primarily with respect to (a) correctness of responding (called *response accuracy*), (b) amount of correct over-responding (described below), (c) the rate of trial completion, and (d) the percent of the student's correct responses that were followed by some form of reward, referred to as *reward accuracy*.

The data for control and experimental subjects are shown in Tables 4-7 below. Table 4 shows data for the three control subjects (C1, C2, C3), using only the regular Workbook system. Tables 5, 6, and 7 show data for experimental subjects E1, E2, and E3 respectively, in baseline sessions (no computer used, same Workbook system as with control subjects), Computer system sessions (instructional material on computer, rewards computer managed and to some extent chosen by the student), and the Probe session (computer but no computer-managed types of rewards, only tutor approval and praise). The first two columns of these tables show the date and workbook lesson number of the material that the student worked on during that session, the third column shows the duration of the session, and the last (15th) column identifies the audio tape

Table 4

Control Group Session Data

	Date	Lesson	Duration	Trials	Total Corr	% Corr	Total Incorr	Cont Errors	Re-directs	Other Errors	Over-Rsps.	Rwds Per Ses	Rwd Accur	Trials per/min	Source Tape#
	28-Sep	8	45	270	225	83.3	45	35	0	10	27	34	15.1	6.0	3
	28-Sep	*9	35	258	230	89.1	28	23	0	5	30	20	8.7	7.4	3
C1	29-Sep	10	45	280	237	84.6	43	33	3	7	315	14	5.9	6.2	23
	10-Oct	16	17	255	235	92.1	20	15	0	5	102	30	12.8	15.0	14
	10-Oct	*17	39	283	245	86.6	38	28	2	8	543	62	25.3	7.3	14
	Average					87.1		26.8	1	7	203.4		13.6	8.4	
	3-Oct	31	31	245	111	45.3	134	99	0	35	0	24	21.6	7.9	4
	3-Oct	*15	15	158	133	84.2	25	18	2	5	17	23	17.3	10.5	6
	6-Oct	45	45	158	111	70.2	47	37	5	5	19	37	33.3	3.5	6
C2	6-Oct	*40	40	243	192	79.0	51	43	5	3	5	30	15.6	6.0	6
	6-Oct	*20	20	282	250	88.6	32	28	4	0	0	26	10.4	14.1	6
	10-Oct	33	33	282	265	94.0	17	15	2	0	0	10	3.8	8.5	16
	10-Oct	*45	45	243	230	94.6	29	20	7	2	0	13	5.6	5.4	16
	Average					85.3		28.6			4.8		13.7	7.5	
	29-Sep	8	30	270	221	81.8	49	39.0	0	10	50.0	37	16.7	9.0	2
	29-Sep	*9	35	258	201	77.9	57	50.0	0	7	77.0	40	19.9	7.4	2
C3	10-Oct	**15	20	99	63	63.6	33	20.0	0	13	0.0	23	36.5	4.8	26
	11-Oct	15	20	318	193	60.7	125	84.0	2	39	477.0	30	15.5	15.9	18
	11-Oct	*16	25	255	126	49.4	129	111.0	4	14	276.0	34	27.0	10.2	18
	n/a	33	18	267	188	70.4	79	75.0	2	2	148.0	23	12.2	14.8	10
	n/a	34	60	245	95	38.7	150	146.0	4	0	263.0	47	49.5	4.1	10
	n/a	65	55	287	232	80.8	55	41.0	0	14	361.0	146	62.9	5.2	12
	Average					60.0		91.4			305.0		33.4	10.0	

n/a was entered when all data were not on the tapes, or could not be verified from tutor's records.

*Subjects were given credit for more than one session because of long breaks (sometimes more than 20 min) between lessons.

**Lesson prematurely started on 10/10 and finished on 10/11.

Table 5

Experimental Subject 1 Session Data

Date	Lesson	Dura-tion	Trials	Total Corr	% Corr	Total Incorr	Cont Errors	Re-directs	Other Errors	Over-Rsps.	Rwds Per Ses	Rwd Accur	Trials per/min	Source Tape#
Baseline														
23-Oct	23	27	213	175	82.1	48	21.0	7.0	20.0	38.0	70	0.4	3.1	29
23-Oct	*24	33	235	191	81.3	44	19.0	8.0	17.0	44.0	80	41.9	4.7	29
1-Nov	25	18	174	120	68.9	54	31.0	7.0	16.0	64.0	46	38.3	7.2	28
1-Nov	*26	45	283	162	57.2	64	45.0	10.0	9.0	0.0	67	41.3	7.2	28
2-Nov	27	31	136	80	59.0	56	25.0	11.0	20.0	0.0	65	81.2	11.8	20
2-Nov	*28	29	136	84	61.7	52	22.0	6.0	24.0	0.0	60	71.4	6.2	20
6-Nov	30	45	255	185	72.5	70	**55	1.0	10.0	70.0	50	19.6	7.8	7
6-Nov	*31	67	151	95	63.3	56	**39	1.0	4.0	0.0	69	72.6	9.0	7
average					68.3		27.2	6.4	15.0	27.0		45.8	7.1	
Computer														
6-Oct	mast 7	5	7	7	100.0	0	0.0	0.0	0.0	0.0	5	71.0	1.6	Comp
11-Oct	6 & 7	8	164	161	98.2	3	3.0	0.0	0.0	0.0	115	70.0	2.2	Comp
8-Dec	n/a	2	13	13	100.0	0	0.0	2.0	0.0	0.0	9	69.0	5.9	Comp
average					99.4		1.0	0.7	0.0	0.0		70.0	3.2	

n/a was entered when all data were not on the tapes, or could not be verified from tutor's records.
*Subjects were given credit for more than one session because of long breaks (sometimes more than 20 min) between lessons.
**Same error repeated many times.

Table 6

Experimental Subject 2 Session Data

Date	Lesson	Duration	Trials	Total Corr	% Corr	Total Incorr	Cont Errors	Re-directs	Other Errors	Over-Rsps.	Rwds Per Ses	Rwd Accur	Trials per/min	Source Tape#
							Baseline							
13-Oct	11	25	212	168	79.2	44	32.0	5.0	7.0	429.0	14	0.1	8.5	12
13-Oct	*12	51	207	107	51.7	100	90.0	0.0	10.0	872.0	15	14.0	4.0	12
15-Oct	14	65	226	221	97.7	5	**99.0	1.0	4.0	432.0	20	9.0	3.5	8
15-Oct	*15	34	318	273	85.8	45	34.0	3.0	8.0	788.0	42	15.3	9.3	22
15-Oct	*16	35	255	195	76.6	60	35.0	5.0	20.0	225.0	125	64.1	7.3	22
16-Oct	17	59	283	232	81.9	51	28.0	7.0	16.0	9.0	73	31.5	4.8	22
15-Nov	36 & 37	33	523	448	85.6	75	15.0	0.0	60.0	n/a	72	16.1	16.1	1
16-Nov	38 - 40	73	794	654	82.4	140	100.0	0.0	40.0	n/a	91	13.9	10.9	1
16-Nov	*41 & 42	15	595	515	86.5	80	40.0	0.0	40.0	n/a	64	12.4	39.7	1
average					80.8		46.8	2.3	22.8	459.2		19.6	11.6	
							Computer							
3-Oct	Sounds	47	39	30	76.9	9	9.0	0.0	0.0	0.0	21	70.0	0.8	comp
1-Dec	63	3.5	26	26	100.0	0	0.0	0.0	0.0	0.0	18	70.0	7.4	comp
1-Dec	*64	38	280	278	99.2	2	1.0	1.0	0.0	0.0	194	70.0	7.3	comp
1-Dec	*65	36	287	286	99.6	1	0.0	1.0	0.0	0.0	200	70.0	8.0	comp
average					93.9		2.5	0.5	0.0	0.0		70.0	5.9	
							Probe							
30-Nov	60	53	276	270	97.8	6	2.0	4.0	0.0	0.0	189	70.0	5.2	comp

n/a was enered when all data were not on the tapes, or could not be verified from tutor's record.
*Subjects were given credit for more than one session because of long breaks (sometimes more than 20 minutes) between lessons.
**Same error repated many times.

Table 7

Experimental Subject 3 Session Data

Date	Lesson	Duration	Trials	Total Corr	% Corr	Total Incorr	Cont Errors	Redirects	Other Errors	Over-Rsps.	Rwds Per Ses	Rwd Accur	Trials per/min	Source Tape#
							Baseline							
31-Oct	45	26	80	32	40.0	48	30	3	15	268	18.0	56.0	3.1	12
31-Oct	*45	42	198	140	70.7	58	43	1	14	190	20.0	14.3	4.7	12
2-Nov	49	30	217	163	75.1	54	33	2	19	197	37.0	22.6	7.2	8
2-Nov	*50	30	215	159	73.9	56	40	0	16	182	36.0	22.6	7.2	22
3-Nov	51	20	236	176	74.6	60	40	0	20	124	20.0	11.4	11.8	22
3-Nov	*51	47	290	223	76.9	67	48	0	19	42	50.0	22.4	6.2	22
7-Nov	59	38	295	255	86.4	40	30	0	10	55	23.0	9.0	7.8	1
7-Nov	*60	30	270	241	89.2	29	23	0	6	n/a	30.0	12.4	9.0	1
average					73.4		35.9			151.1		21.3	7.1	
							Computer							
20-Sep	Sounds	31	39	39	100.0	0	0	0	0	0	27.0	69.0	1.6	Comp
20-Sep	1	15	130	128	98.5	2	2	0	0	0	90.0	70.0	2.2	Comp
21-Sep	2,3,4	45	465	465	100.0	0	0	0	0	0	325.0	70.0	5.9	Comp
18-Oct	31 & 32	40	510	508	99.6	2	0	2	0	0	340.0	69.0	12.7	Comp
average					94.3		7.6			30.2		59.9	5.9	
							Probe							
15-Nov	61	85	285	284	99.6	1	0	1	0	0	170*	60*	14.6	Comp

n/a was entered when all data were not on the tapes, or could not be verified from tutor's records.
*Subjects were given credit for more than one session because of long breaks (sometimes more than 20 minutes) between lessons.

number from which the data were taken. The other columns will be described as the comparisons are made between the two different instructional systems.

Correct Responding

The 4th column of the tables shows the number of trials (tasks, problems, words to be read, etc.) in the lesson used in each session, the 5th column shows the number of trials on which the student responded correctly, and the 6th shows the percent of trials correctly responded to. The data from the three control subjects (all relevant only to the Workbook condition) make possible a between-group comparison with data from the experimental condition (computer-managed procedure) of the experimental subjects. With such small groups (3 subjects in each group), this comparison is confounded with individual differences. The within-subject comparison of the experimental subjects' baseline and experimental conditions is probably more useful, but the performance of the control subjects does play an important role in determining that the experimental subjects' baseline performances are typical for the Workbook system being used in this research.

From Table 4 it can be seen that Control Subject 1 (C1) was studied for 5 sessions, and had a relatively high percent of correct responding in each, ranging from a low of 83 to a high of 92, with an average of 87 for the 5 sessions. Similar average percent correct values for all three control subjects and for the baseline and Computer conditions for the experimental subjects are shown in Figure 1 below. Two points are clear from this figure. First, the experimental subjects' baseline averages are quite similar to the averages for the control group subjects, suggesting that the experimental subjects' performances are typical of what could be expected with this type of instructional system. Second, the performance of the experimental subjects when using the computer is considerably better than their own performances without the computer and better than the performances of the control subjects. Statistical significance tests

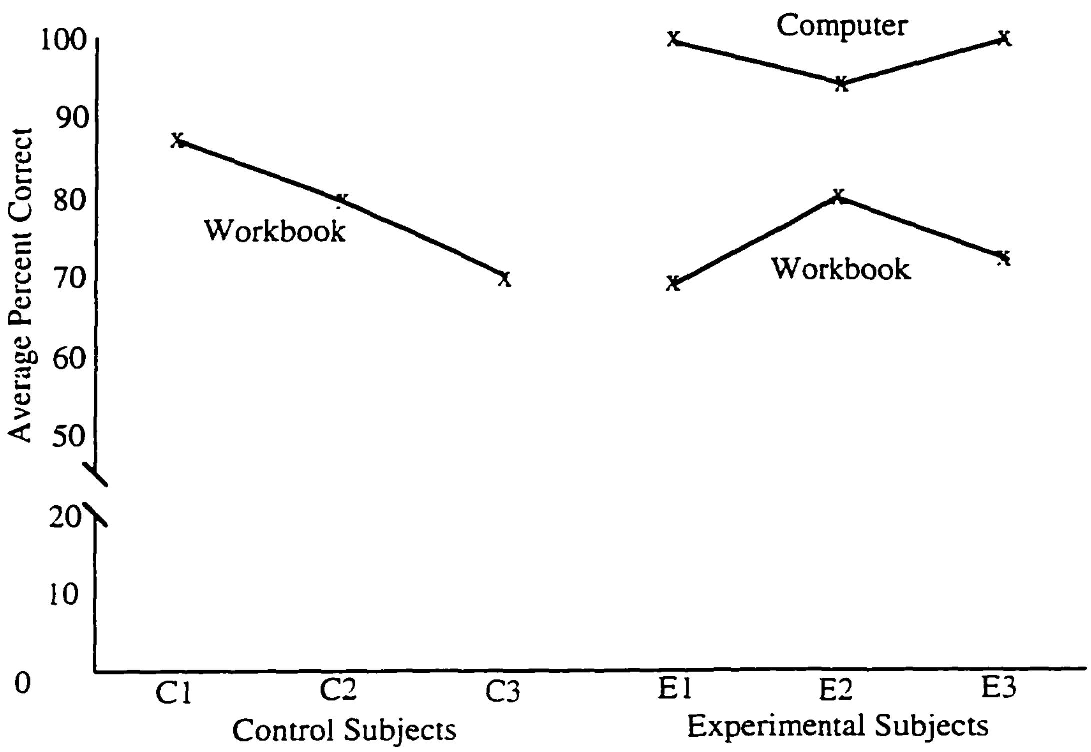

Figure 1. Response Accuracy.

with such small samples are of questionable value, but using a t-test both differences are statistically significant at the .05 level. Using the average values shown for each set of conditions in Tables 4-7 (the same as the values shown in Figure 1 above), the overall mean for the three control subjects is 78.3, and for the Experimental subjects" computer condition is 97.3. Using a t-test, the difference between these two means is significant at the .05 level ($t = 3.47$, $df = 4$, $P < .05$, two-tailed test). Similarly, the overall mean of the three differences between the Experimental subjects' baseline and their Computer condition is 23.3, which is significantly different from zero at the .05 level ($t = 4.34$, $df = 2$, $P < .05$, two-tail test).

Probe data were very much like the Computer session data, in having very high percent correct responses.

Types of Errors

Column 7 of Tables 4 through 7 shows the total number of incorrect responses made for the session, and columns 8, 9, and 10 show the types of errors. Content errors consist in word mispronunciations, saying the wrong word, or giving incorrect answers to questions regarding text material; redirects are audible prompts made by the tutor for the student to return to the task; other errors are false starts/breaks in word decoding, stutters, stammers, reading onset delays greater than 5 sec, and irregular speech errors (e.g., "the" pronounced as "dee", "that" pronounced as "dat", etc.). For all of the subjects most of the errors were content errors, but there are subject differences with respect to the other kinds of errors. For example, Control Subject 2 (C2) had a large number of other errors on his first session, but from then on very few such errors. These other errors consisted mainly in irregular speech errors such as "that" pronounced as "dat"; "ck" pronounced as "x", false starts, repeated errors due to fast reading, and stammers. Similarly C3 had many other errors for two of the sessions, largely because difficulties with the "th" sounds. Experimental Subject 1 (E1) had more redirects than any of the other subjects, and also quite a few other errors. The redirects were related to arguments with the tutor who in some cases had provided differing instructional methods and criteria, walking away from the table, noncompliance with requests to read, and "frustration" responses. The other errors were mispronunciations of the "th" sound and pronouncing "ch" as "sh", stammers, and false starts.

It was not useful to compare error types for the Experimental Subjects in the baseline condition with errors in the Computer condition because in the Computer condition almost no errors were made. The only exception to this statement is for E2 on his first Computer session, where he made a number of letter sound errors, and repeatedly failed to pronounce a sound correctly even after being corrected. Perhaps a useful conclusion would be that with the Workbook system most of the subjects make quite a few content errors, but with the Computer system there are very few. This issue will be discussed in the next chapter. Significance tests are unnecessary for these comparisons.

Correct Over-responding

Column 11 of Tables 4 through 7 shows the number of over-responses that were recorded during the session. Most of the over-responding occurs with the Workbook system when the student responds correctly but the tutor does not react as soon as the correct response occurs. It is clear from the tables that with the computer there is almost no over-responding. Again, no significance tests were necessary. Probe data were very much like the Computer session data, in having no over-responding.

Reward Accuracy

Column 12 of Tables 4 through 7 shows the number of rewards that were delivered during the session. Column 13 shows the percent of correct responses that were rewarded. In the Workbook system the rewards consisted of verbal praise provided by the tutor, and in the Computer system they were randomly selected sounds, video clips, clip art, and an opportunity to play computer based games. The computer was programmed to provide a reward on 70% of the correct trials (Computer sessions, column 13 for E1, E2, and E3) and it is quite clear that the tutors seldom achieved this reward percentage (Baseline sessions, column 13 for E1, E2, E3, and all sessions for C1, C2, C3). As above, significance tests were unnecessary. Reward accuracy in the Probe condition was generally higher than during the baseline condition.

Trial Rate

Dividing the number of trials that were presented in a session by the session duration gives the trial rate in trials per minute, shown in column 14 of the tables. It is important to know what the effect of the computer is on the rate at which the students make contact with the instructional material. Because there are considerable individual differences in rate of work, in the Workbook or on the computer the most useful comparison is between baseline and computer rates for the experimental subjects, although that is not as useful as it might be because of the different kinds of material in the different lessons. In general subjects responded slightly slower in the Computer sessions. Trial rate in the Probe condition was like that in the Computer conditions in being somewhat lower than the average rates in the baseline condition.

CHAPTER V

DISCUSSION

In this study a highly individualized Workbook system of education (Project Help) was compared with a Computer-based version of the same individualized system, using the same kinds of educational materials. It should be pointed out that the present Computer system is also a tutorial system involving a person, the tutor, who is completely occupied with a single student/computer unit. Future developments in the same educational setting (Project Help) will probably move in the direction of reducing the necessity of such individualized attention, by allowing one tutor or system manager to monitor the behavior of a number of students, each working at his own computer station. The present system, however, did not render the tutor unnecessary, but it changed the nature of the tutor's task somewhat.

The data collected in this study identified several advantages of the computer-based over the ordinary tutorial system. Using the computer the Experimental Subjects were considerably more accurate than when they worked on similar material with the regular Workbook procedure. All types of errors (content, redirects, and other errors) were drastically reduced in frequency when the computer was used. Continuing to make correct responses to the same item, over-responding, was also greatly reduced; and the percent of correct responses that were followed by a reward was greatly increased.

The increased reward accuracy can be easily understood in terms of the capacity of the computer to automatically provide some form of reward to a specified proportion of correct responses. When the tutor identified a response as correct by making an F8 response on the computer keyboard, the computer presented the previously reward.

With respect to the over-responding with the Workbook system, the tutor identified a response as correct and provided some form of verbal praise. From Table 4 it can be seen this happened for the control group on about 12 to 30 % of the correct trials and with the experimental subjects (Tables 5-7) it happened during baseline on about 20 to 50% of the correct trials. The computer, of course, provided a reward on 70% of the correct trials because of the way it was programmed, and the reward was available as soon as the tutor made the keystroke, after which tutors typically observed the student's choice of reward and also watched the computer during some of the reward presentations. With the Workbook procedure, however, the tutor was always somewhat busy recording (by hand) and classifying the student's responses. Although the tutors made various notes for themselves during the computer sessions, there was no critical demand during this procedure that distracted him/her from the student's responses as they were being made. From the data in the tables, and also from observation of some of the sessions it seemed that much of the over-responding was behavior by the student aimed at inducing the tutor to react to a trial response.

The increased response accuracy in the Computer condition is probably due largely to the consistency, quality and variability of the rewards for correct responding. It is also to some extent due to the fact that the trial item presentation on the computer screen was easier to read, and was not embedded in a page of several similar items as was common with the workbook presentation. Because the tutor was not burdened with a recording task the reinforcement was more likely to be provided immediately after the response. This means that it would have a better strengthening effect on the correct response than if it was delayed. It also seemed quite clear that the tutor's verbal praise, which did not vary much from one offering to the next (although the tutors tried to make their comments variable), was not as interesting to the students as the events programmed on the computer. It is true that some of the computer-delivered events were not much different from a voice saying "good job," but the student's opportunity to choose the reward from the reward menu, and the randomizing of the various reinforcing events that occurred when the student did not have a choice, probably resulted in a considerably more interesting situation for the student.

In this respect, it is important to repeat a procedural detail about the reward system. Using the reward menu, the student selected the reward that would be delivered if the next response was correct. This feature of the reward situation is in a sense a motivating variable, an aspect of the situation that makes producing a correct answer more important to the student, and probably generates a more effective form of "trying to figure out the correct answer." "Trying" in this sense is hard work, and when correct answers are not very important, such hard work is not likely to occur. In other words, the immediacy, quality and variability of the rewards on the computer result in their having a better strengthening effect on the correct response that preceded the reward, but probably even more important, these reward features are probably responsible for a more motivated approach to the lesson items.

The fact that the Probe condition resulted in the same high accuracy as the Computer condition is understandable, if the analysis above with respect to the decreased demand on the tutor for recording is correct. And, in the Probe condition there was the improved visual stimulus feature of the computer screen presentation of the lesson material.

There are several serious flaws with this research project, largely resulting from the very limited computer facilities available to the researcher, and the limited time available to complete the research as the school year was coming to its end. Most important, it was not possible to obtain enough data in the Computer condition to be sure of the size of the effects or of their duration. The considerable variability of the results across subjects and lessons strongly implies that there are a number of important uncontrolled variables operating. It is to some extent a tribute to the robustness of the effects that any observable differences emerged given the small number of critical observations.

The very small amount of Probe data, where the computer was used but without the computer-based reinforcers, leaves the critical components of the independent variables pretty much unexplored.

Nevertheless, this study clearly showed that a computer supplement to an already effective learning system, the Direct Instruction approach used in Project Help, does have some important advantages. The effort and resources required to develop a flexible and fully automatic multimedia interactive system are massive, and as a result there are very few such systems available in elementary, secondary, and higher education. The results of the present study strongly suggest, however, that educators should not wait for such developments. This project took place over 3 years ago. Because of the rapid advances in computer and multimedia equipment and programming, relatively simple supplemental systems of the sort studied in this research can be rather easily developed in almost any educational setting, and can effect significant improvements over many existing noncomputerized educational procedures.

Appendix A

Human Subjects Institutional
Review Board Approval

Human Subjects Institutional Review Board

Kalamazoo, Michigan 49008-3899
616 387-8293

WESTERN MICHIGAN UNIVERSITY

Date: March 13, 1995

To: Hodge, Vincent O

From: Richard Wright, Interim Chair Richard A Wright

Re: HSIRB Project Number 94-10-14

This letter will serve as confirmation that your research project entitled "Interactive multi-media: Effect of reinforcer choice on reading in at risk students" has been approved under the expedited 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 must seek specific approval for any changes in this design. You must also seek reapproval if the project extends beyond the termination date. In addition if there are any unanticipated adverse 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: Mar 13, 1995

xc: Farris, Howard, PSY

Appendix B

Informed Consent Sample Document

INFORMED CONSENT TO PARTICIPATION IN RESEARCH AND DATA COLLECTION

The purpose of this form is to guarantee parent and student consent to participation in scientific research. All names are kept condfidential and the results of data collection are presented without revealing ther identity of participants.

DESCRIPTION OF RESEARCH:

This investigation will assess the effects of allowing a choice of reinforcement on students using a computer generated multi-media (sound, video,games etc.) reading program. Students will be tutored as a part of the Project Help reading program, but will perform some exercises lessons on a computer. This investigation will be a part of a doctoral dissertation.

Data will be collected so that we can assess the impact of using this new format on the students attention to task, and overall performance. Information collected will be: 1) Total time on task;
2) Total number of responses per session lesson ; 3) number and type of reinforcer choices ; 4) Percent correct responding ; 5) correction trials. All data will be strictly confidential, and any presentation of this material will not reveal the participants identity.

There is no risk to students, as they will recieve the same instructional material as the other project students. the only difference is that they will work on computers at times that others will be working from workbooks.

CONSENT TO PARTICIPATE:

PARENT

I understand that you are seeking my permission to have my youngster participate in an investigation of the effects of computer generated multi-media reinforcer choice on reading in children. I have read the above description and understand that all the usual methods of instruction will be used, as well as the computer format.

I understand that I may also withdraw my child from this study at any time without any negative effect on the services to my youngster.

If I have any questions or concerns about this study, I may contact:

Dr. Howard Farris at 616-387-4498
Mr. Vincent Hodge at 616-764-0240
Chair of Human Subjects-
Institutional Review Board: 616-387-8293
Vice President for Research: 616-387-8298

My signature below indicates that I give permission for_________________________(youngsters name)to participate in the investigation of the effects of choice of reinforcer on learning in "at-risk" students using interactive multi-media; for the results of the investigation, to be used as a part of the research project described above.

PARENT SIGNATURE:________________________________

DATE:____________________________

Appendix C

Data Collection Program

Reward Handling Stack

This stack has no user interface. The sole purpose of this stack is to handle individual requests from lesson stacks to perform actions of files. Currently, the lesson stack will send an absolute file reference to this stack. This stack will decide on the file's type, and open the file with the appropriate application. File types currently supported are 'PICT', 'PNTG', 'MooV', and 'sfil'. Picts, paintings and QuickTime movies are displayed with HyperCard. The Finder handles sound files.

In order for this system to work, all files must be contained in a folder called Rewards that is at the same directory level as the lesson stacks.

'30/95 2:49 PM HyperTalk Script of bkgnd button id 3

```
on mouseUp
  if the short name of this card contains "title" then
    beginLesson
    exit mouseUp
  end if
  beginExercise
end mouseUp

on beginLesson
  global userName -- name of student
  global fileName -- TEXT file to hold data
  global thePath  -- our current path

  ask "What is your name?"
  if it is not empty then
    put it into userName
    put thePath & ":Data:" & userName && the short date into fileName
    open file fileName
    setUpFile
    go to next card
  end if
end beginLesson

on setUpFile
  global userName, fileName
  write userName && the short date && the time to file fileName
  write return & return to file fileName
  write "Lesson/Question" & tab & "Attempts" & tab & "Time (in seconds)" to fiLE
  write return to file fileName
end setUpFile

on beginExercise
  global fileName
  write return & return to file fileName
  write the short name of this stack & the short name of this card -
  to file filename
  write return to file fileName
  go next card
end beginExercise
```

Appendix D

Reward Stack Program

```
on doReward
  put the random of 10 into It
  if It ≤ 5 then exit doReward
  put the random of 10 into It
  if It ≤ 4 then computerChoose else userChoose
end doReward

on computerChoose
  put the random of 3 into It
  if It = 1 then handleSound
  if It = 2 then handleMovie
  if It = 3 then handlePict
end computerChoose

on userChoose
  global userPref
  if userPref = "no choice" then
    put the random of 3 into It
    if It is 1 then put "Sound" into userPref
    if It is 2 then put "Movie" into userPref
    if It is 3 then put "Picture" into userPref
  end if
  put userPref into It
  if It is "Sound" then handleSound
  if It is "Movie" then handleMovie
  if It is "Picture" then handlePicture
end userChoose

on handleSound
  global thePath, soundList
  put the random of the number of lines in soundList into It
  put thePath&":Rewards:"&line It of soundList into theSound

  set the cursor to watch

  MusicBox "open", "one"
  checkError (the result)

  MusicBox "system 7 sound play", "one", theSound, "false"
  checkError (the result)

  repeat forever
    MusicBox "busy", "one"
    if the result contains "Error" then checkError (the result)
    if the result is "false" then exit repeat
    set the cursor to busy
  end repeat
  set the cursor to watch

  MusicBox "close system 7 sound", "one"
  checkError (the result)

  MusicBox "close", "one"
  checkError (the result)
end handleSound

on handleMovie
  global thePath, movieList
  put the random of the number of lines in movieList into It
  Movie thePath&":Rewards:"&line It of movieList
  send Play to window line It of movieList
end handleMovie
```

```
on handlePicture
   global thePath, pictureList
   put the random of the number of lines in pictureList into It
   picture thePath&":Rewards:"&line It of pictureList
end handlePicture

on checkError theError
   if theError is not empty then
     set the cursor to watch
     answer theError with "Cancel"
     MusicBox "close system 7 sound", "one"
     exit to HyperCard
   end if
end checkError

on openCard
   Send colorMe to this card
   pass openCard
end openCard

on closeCard
   lock screen
   pass closeCard
end closeCard

on colorMe
   AddColor colorCard,stamp,30
end colorMe

on openStack
   AddColor install
   pass openStack
end openStack

on closeStack
   AddColor remove
   pass closeStack
end closeStack
```

Appendix E

Tutor Data Collection Procedure

PROJECT HELP

TUTOR DATA COLLECTION PROCEDURE

In addition to tutoring (e.g., direct instruction), your role as tutor involves data collection, data analysis, reporting and providing feedback to monitors and parents. You may also participate in the collection of data on the behavior of special groups of students (e.g., investigative research subjects, etc.) and gather information which can be used to evaluate the effectiveness of the projects tutorial programs.

Prior to serving as tutor/monitors, you will be given training, materials and an opportunity to practice using the procedures involved. Assistance is available if you have any questions at any point in the semester.

You will be primarily concerned with collection of data on four different aspects of direct instruction teaching. All of these deal with the effectiveness of the delivery and use of the instructional material and your interactions with the student. summarized below are the tasks and categories required:

A. Taping

1. Load blank cassette in recorder provided and begin recording at start of session.
2. Stop recording during long breaks and at end of session.
3. Return tapes and recorders to project office.

B. Manual Data Collection

1. Positive Reinforcement
   a. Record the number of instances of positive feedback given for correct responses (when possible).

   b. Record the number of instances of corrective feedback given for incorrect responses (when possible).

   c. Monitors record number of instances of positive feedback, no response, and the number of punishments.

2. Pacing
   a. To determine the rate at which the tutor is teaching, record the number of correct and incorrect responses for some period of time (e.g., 1 minute) and add them together.

3. Correction and Errors
   a. Record the number and type of errors the student makes per unit.

Appendix F

Direct Instruction Teaching Technique

TEACHING TECHNIQUES FOR DIRECT INSTRUCTION

ORAL RESPONDING

1. **READING IS VERBAL BEHAVIOR** (e.g., mediated by audience/tutor).
2. Facilitates student involvement which increases attentiveness.
3. Gives student repeated practice (e.g., repeated acquisition).
4. Gives teacher objective measure of student performance (e.g., progress).
5. Gives opportunity to test.
6. Teacher **must watch** students eyes and mouth as s/he responds. Teacher must tune in to **low performers** and shape approximations to desired responses.

SIGNALS

1. Signals tell student when to make response (e.g., S^d for response).
2. Signals enable student to perform under consistent conditions.
3. **REMEMBER**: Talk first---then signal. Give directions, allow "thinking" pause (1to 2 seconds), then signal for the response. Response latency greater than ~~10~~ 5 seconds is in error. Watch students eyes and mouth while s/he is responding. Don't let your eyes drift back to the teachers manual until the response is completed.

PACING

1. A brisk pace increases attentiveness and reduces errors.
2. Begin directions for the next question immediately after the student makes the response.
3. For young students, work briskly for 5 minutes; followed by 15 second breaks.
4. Providing a fast past presentation does not mean that a teacher rushes students, requiring student to respond before correct response is determined.

CORRECTION

1. **Correct all errors** and repeat exercises until all responses are correct (e.g., errorless learning).
2. Give extra practice on error items . **FIRM THEM.**
3. Correct the response not the individual. Good line to remember: "Good job, that word close; Lets try it again."
4. You can also model for students on difficult tasks.
5. **REMEMBER, CORRECTIONS ARE CRITICAL TO GOOD INSTRUCTION.**
6. Correct errors of inattentiveness (e.g., re-direct; praise attentive behavior; be direct).
7. When correcting errors due to lack of knowledge, use specific correction procedures (e.g., watch for vertical; use model-lead-test-retest; use model-test-retest-delayed test).
8. **FIRM** students to an acceptable criterion of performance.

Appendix G

Permission to Modify Copyrighted Material

S I M O N & S C H U S T E R

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July 15, 1998

To: Vincent Hodge

Fr: Michelle Johnson
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