THE RELATION OF COMPUTER ASSISTED INSTRUCTION TO THE DEVELOPMENT OF READING SKILLS IN FIRST AND FIFTH GRADERS

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PREFACE

This investigation sought to determine the relationship between computer assisted instruction and the development of reading skills of first and fifth graders. The study employed a quasi-experimental design which involved two schools of first and fifth graders -- one serving as the experimental group and a second serving as a control group. Students in the experimental group were taught reading using the traditional classroom method which was augmented with computer assisted instruction. The experimental first grade group was exposed to 60 minutes (three 20 minute sessions) of computer assisted instruction on reading per week while the experimental fifth grade group was exposed to 90 minutes (three 30 minute sessions) of computer assisted instruction on reading per week. Students in the control group were taught reading using only the traditional classroom method.

Students' reading skills were assessed at the beginning of the school year using the CTBS Form U. Reading skills were once again assessed at the end of the school year. Development in reading skills was operationalized as the difference between pre and postscores on the CTBS Form U.

Findings demonstrate a significant treatment effect for first grade females and fifth grade males. Restated, improvement in reading skills for first grade females and fifth grade males is significantly related to the treatment. This findings was not upheld for first grade males and fifth grade females. The implications of these findings are discussed.

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CHAPTER I

INTRODUCTION

In the early 1900's Max Weber compared bureaucracies to highly efficient machines (1946). "The fully developed bureaucratic mechanism," he wrote, "compares with other organizations exactly as does the machine with nonmechanical modes of production." Since Weber's astute comparison, the school as a bureaucracy has been similarly portrayed. As early as 1920, Professor Ellwood Cubberly, Dean of Stanford's School of Education, proclaimed American schools to be factories in which raw materials are to be shaped and fashioned into products (Cubberly, 1920). In short, educators have long been pictured as industrial managers and students as the raw materials to be inducted into the production process.

The "factory" view of public education is, in part, the result of the dramatic growth experienced by this institution during the twentieth century and the corresponding increase in its organizational size and complexity. But despite the high level of structure and the proclaimed efficiency of the bureaucratic model, there is mounting evidence the educational system of the United States has been less than successful. A 1983 study sponsored by the United States Department of Education reported 13 percent of all 17 year olds are functionally illiterate (Pankel and Petersen, 1985). The same study reported almost 40 percent of all 17 year olds cannot draw inferences from written material. Similarly, only one-third of all 17 year olds can solve math problems involving several steps. Additionally, between 1962 and 1980, average verbal scholastic aptitude scores have declined by more than 50 points while math scores have dropped an average of 36 points (Pankel and Petersen, 1985).

While the statistics reported by the U. S. Department of Education point to a very real problem, these statistics do not identify the source of the problem. Conceivably, identification of the source of the problem begins with a reassessment of the purpose of an educational system.

The intended function of an educational system is to further the growth and development of the total individual (Silver, 1983; Parsons, 1964). The school uses experts (teachers) to teach individuals (students) the knowledge, skills, and values necessary to function in the world outside the family (Parsons, 1964). Currently, students are expected to learn to read, write, and do arithmetic -- skills taught by specially trained experts. Schools also teach students about the larger world through courses such as history, geography, and science. Additionally, students learn the values of the larger society, including those values pertaining to organizations -- for example, obedience to rules and cooperation.

The total educational experience is aimed at helping each individual grow in knowledge and understanding of self. Given this goal, one important question to ask is "To what extent does the present structure of education promote or impede the achievement of this goal?" The characteristics of bureaucratic schooling suggest a system which serves primarily the needs of educators (although not necessarily to their liking) and secondarily the needs of those being educated. Age-graded classrooms and promotional schedules based on rules, for example, allow for few exceptions. To this extent, education has experienced what Robert Merton (1968) has so aptly labeled goal displacement -- the goal of the educational system (i.e. developing the total individual) has become secondary to the goal of bureaucratic efficiency.

Psychologist Fred Keller has long been a staunch critic of traditional classroom structure (Chance, 1984). Keller's criticisms are based generally on behavioral science and particularly on the principles of reinforcement. According to Keller, learning is an individual phenomenon, not a group phenomenon. The primary problem with the traditional classroom structure is it assumes all of the students in a given class are much the same. Such an assumption, according to Keller, is incorrect. Some students move quickly through material. Others move more slowly. But, as Keller notes, with group instruction, teachers are forced to teach to the middle student. Hence, some students will be bored because the teacher will be moving too slowly. Others will be struggling to keep up because the teacher will be moving too fast. And if the material is cumulative, as it is in math, science, and languages, the slower student will get further and further behind. Additionally, the traditional classroom provides very little opportunity for students to do anything during instruction. They are simply passive participants in the learning process. What's more, such group instruction is not conducive to personal contact. While students may get some individual help now and then, such help is predictably minimal. Finally, for Keller, the units of instruction in the traditional classroom are too big. Teachers generally cover too much ground before students have an opportunity to discover how they are actually doing. In short, according to Keller, there are very few rewards built into the traditional structure.

In a seminal article (1968), Keller presented a method of course instruction designed to dispose of rigid scheduling and to allow students to progress at their own pace. To replace traditional teaching techniques, he proposed that teachers prepare a large number of learning units for course materials. For Keller, typical units involve a major topic and often coincide with a chapter or chapter section of a text on the subject. A typical course might be divided into 20 or more learning units. Keller suggested that teachers allow students to work at their own pace starting with unit one. Students would pass a short quiz over each unit at a high level of proficiency (usually 90 percent or better) in order to advance to the next unit. A student's grade would not be based on an average percentage of questions answered correctly, but rather on the number of units covered. This method of instruction is referred to by Keller as the personalized system of instruction or PSI.

Keller's learning principles closely resemble those learning principles embraced by computer assisted instruction. The development of computer assisted instruction at Stanford University provides a representative case history of the growth of both the technology and the widespread acceptance of computer assisted instruction. In 1965, IBM and a Stanford group jointly developed a program of computer assisted instruction using an IBM 1500. The program was operative in 1966. From the small start of computer drill for 41 fourth-grade children in one school, the system grew until by 1968 it was used by 3000 students in seven nearby schools and in several more distant schools including Mississippi and Kentucky. The system provided lessons in initial reading, arithmetic, spelling, logic, and elementary Russian.

The success of the IBM/Stanford project is a testimony to the growing applicability of computer assisted instruction in education and to the many ways in which computers have already begun to alter the learning process (Watt, 1984; Walker and Bergmann, 1983; Fiske, 1983). The reasons for this success are many. First, computers are in themselves intrinsically rewarding. Teachers have reported that students line up before and after school and during recess periods to use the computers.

Second, computers encourage experimentation -- an important aspect of self-learning which is all too rare in traditional classrooms. Such experimentation is largely possible because computers are "noncritical", a desirable attribute which serves to take the "fear" out of making mistakes. Hence, students feel freer to take risks that they might not take otherwise.

Third, computers provide the opportunity for several kinds of feedback not typically available in the classroom -- for example, feedback concerning the child's speed of response or immediate evidence on the quality of performance relative to past social norms or the child's own prior performance. This immediate feedback can serve to maintain a high level of motivation to learn

Fourth, computers allow for highly individualized instruction at a pace set by the student. In fact, computers have a tendency to make distinctions such as grades and tracks within grades irrelevant. With computers in the classroom, each student can be taught at his/her own level of learning. In fact, the student can be constantly queried and at each stage of the learning process the teacher can determine quite precisely what the student knows. Hence, bright students can move quickly, and slower students can take more time. In addition, students tend to think of their mistakes as being private when they are working with a computer and suffer little, if any, loss of face. As a consequence, they seem more willing to make responses even when they are unsure of the answers. In short, teachers no longer have to teach to the middle, hoping that the bright students aren't getting bored or the slow students aren't lagging behind. What's more, this individualized level of instruction means that learning, not teaching, is the primary objective.

Fifth, with the computer as teacher, the "locus of control" is shifted to the learner. The learner is in command. Hence, to some degree the learner can, by testing his or her own ideas, direct the learning process.

Sixth, computers are infinitely patient with students (Heck, 1983). They do not lose their "tempers." They do not get frustrated. They can methodically perform the same task over and over again with no change in "personality".

Seventh, computers are altering student-teacher relationships in significant ways. Educators are coming to agree that the challenge in the computer age is learning to be a facilitator of the educational process rather than the source of knowledge -- a sharp departure from educators' views of teaching in the traditional classroom (Heck, 1983).

Need for the Study

While there is a growing body of literature on the use of computer assisted instruction at all levels of public school, very little of this literature is empirically based. For the most part, published findings on the use of computer assisted instruction within the classroom have been largely based on qualitative impressions formed by teachers over a period of time. Additionally, what research has been done has largely employed the one-group pre-test-post-test design. When differences between the pre- and the post-test are observed with this design, it is difficult to establish the source of the difference. That is, researchers can only speculate that any observed difference between pre- and post-test scores is the result of the treatment -- use of computers in the classroom. In short, there is a limited number of empirical studies whose methodological rigor provides a working database of objective findings from which some general patterns regarding the effectiveness of computer assisted instruction can be observed. Additionally, the majority of studies, to date, have not looked at a major system of computer assisted programs developed to parallel the textbooks used in the traditional classroom. Hence, there is a great need for well-defined empirically based research examining computer assisted instruction designed to parallel the traditional textbook approach to learning.

Statement of the Problem

The purpose of this study is to determine the relationship between computer assisted instruction and the reading skills of first and fifth graders. This study will employ a quasi-experimental design to compare a group of first graders and a group of fifth graders whose reading lessons are augmented with computer instruction to a group of first graders and a group of fifth graders, respectively, whose reading lessons are not so supplemented.

Research Question

This study addressed the following research question:
Does computer assisted instruction significantly relate to growth in the reading skills of first and fifth graders?

Hypotheses

Research Hypothesis 1

Use of computer assisted instruction is significantly related to first graders' development of reading skills as measured by the Comprehensive Test of Basic Skills Form U Level B.

Null Hypothesis 1

Use of computer assisted instruction is not significantly related to first graders' development of reading skills as measured by Comprehensive Test of Basic Skills Form U Level B.

Research Hypothesis 2

Use of computer assisted instruction is significantly related to fifth graders' development of reading skills as measured by the Comprehensive Test of Basic Skills Form U Level G.

Null Hypothesis 2

Use of computer assisted instruction is not significantly related to fifth graders' development of reading skills as measured by Comprehensive Test of Basic Skills Form U Level G.

Limitations of Study

This researcher recognizes the following limitations:

1. Inability to randomize subjects reduced the equivocal status of the two groups -- and hence weakened the treatment effect to some degree.

2. This study was confined to first and fifth graders in two elementary schools. Such confinement limited the study's generalizability.

3. Definition of reading skills was limited to a single reading skills instrument. Use of other reading skills instruments may have demonstrated different results.

Assumptions

In this study it was assumed that:

1. The two classes of first graders were representative of first graders.

2. The two classes of fifth graders were representative of fifth graders.
3. The teachers of the first grade classes were similar in their traditional teaching styles.
4. The teachers of the fifth grade classes were similar in their traditional teaching styles.
5. The traditional activities of the classes were similar. Hence, the one difference between the classes in the two different schools was the inclusion or exclusion of computer assisted instruction.

Definition of Terms

A microcomputer is a general-purpose digital computer that is small, inexpensive, and simple to use. Most microcomputers have between 64k and one megabyte of random access memory (RAM). This means that they can store between 2^{16} (65536) and 2^{20} (1048576) bytes or characters in RAM. A microcomputer can drill, tutor, simulate, and entertain.

A mainframe computer is a large computer which is capable of processing large amounts of data at very fast speeds with access to billions of characters of data.

A minicomputer is a computer system which has smaller computer storage, slower processing speeds, and lower costs than a mainframe. However, it generally has larger computer storage, faster processing speeds, and higher costs than a microcomputer.

A floppy disk is a flexible plastic storage medium which can typically store between 140 kilobytes (thousand characters) and 1.2 megabytes (million characters) of information.

A hard disk is an aluminum storage medium which can store many times more information than a floppy disk. Additionally, a hard disk works many times faster than a floppy disk. Typically, a hard disk stores 20 or more megabytes of information.

The central processor is the brain of the microcomputer. It is the part of the computer that does all the hard work. All other elements of a computer are connected to the central processor in some way.

Computer assisted instruction refers to a programmed-learning approach in which specific educational objectives are achieved through step-by-step instruction (Hassett, 1984). Generally speaking, the student receives a stimulus and responds at his/her own rate (O'Donnell, 1982). Computer assisted instruction facilitates self-pacing and diversifies and extends content selection.

CHAPTER II

REVIEW OF RELATED LITERATURE

Review of Learning Theories

Psychologists and educators have long been fascinated with the process by which individuals learn. This fascination is perhaps best demonstrated by the numerous theories which have emerged to explain this intriguing process. Embedded within this body of theory are two opposing positions: empiricism and rationalism. These two positions have been constant combatants within the intellectual arena for centuries with strong support for each still recognizable today.

Empiricism is the view that <u>experience</u> is the only source of knowledge. Although some knowledge is derived from intellectual reflections regarding relations among experiences, empiricism gives special emphasis to sensory experience (Bower & Hilgard, 1981). Empiricism can be characterized by four major principles: (1) sensationalism -- the hypothesis that all knowledge originates through sensory experience; (2) reductionism -- the position that all complex ideas are constructed out of a basic stock of simple ideas, and that complex ideas are, in turn, reducible to these simple ideas; (3) associationism -- the notion that ideas or mental elements are connected through the operation of association of experiences that occur closely together in time (contiguity); and (4) mechanism -- the notion that the mind is like a machine fashioned from simple elements with no mysterious components.

A major thesis of empiricism is that learning occurs through the contiguous association of events or ideas. This framework of association was accepted by almost all learning theorists of the first half of this century including Pavlov, Guthrie, Hull, and Skinner. The only real opposition to this thesis was among Gestalt psychologists, information-processing theorists, and cognitive psychologists.

Rationalism is the general philosophical position that reason is the prime source of knowledge (Bower & Hilgard, 1981). In effect, reason rather than sense data, authority, revelation, or intuition provides the only valid basis for knowledge, belief, and action. For the empiricist, ideas are "passive copies of sense data"; for the rationalist, sense data are unstructured chaos, providing only raw data to an interpretive mechanism that views these raw data as clues regarding their probable source and meaning. The raw data can be interpreted only according to certain forms -- more precisely, according to certain classes of innate perceptual assumptions with which the mind begins.

A host of contributors have enriched the learning theory literature. Although too numerous to list, some of the more important contributors should be mentioned.

Ivan Pavlov: Classical Conditioning

One of the most acclaimed theories of learning was developed by Ivan Pavlov, a Russian psychologist, who believed that learning is based on conditioned reflexes. Pavlov (1927) demonstrated his learning theory through his famous experiments with dogs. His theory embraced three important concepts: (1) a natural reflex, (2) an unconditioned reflex, and (3) an innate or inherited reflex -- for example, salivating at the sight of food. For Pavlov's experiments, food was the unconditioned stimulus. When confronted with the sight of food, Pavlov's dogs salivated . In effect, salivation for the dogs was precipitated by the sight and taste of food. If, however, Pavlov reasoned, a neutral stimulus (the sound of a bell, for example) were to coincide with or immediately precede the unconditioned stimulus (food), the neutral stimulus would become a signal - symbolizing the arrival of food. Pavlov was able to demonstrate that after a few pairings of the sound with the food, that the previously neutral stimulus was no longer neutral. Rather, it became an active stimulus capable of eliciting a response.

In Pavlov's experiment, the sound was emitted by a metronome. The reflex developed by this procedure was not a natural response, but a learned one. It was acquired as a result of experience, and constituted, for Pavlov, the basic rudiment of the learning process.

<u>John Watson: Behaviorism</u>

John Watson's behavioristic approach to learning was greatly influenced by the work of Pavlov. Watson (1928) worked from the basic premise that all behavioristic observations could be presented in the form of stimulus and response. For Watson, the aim of behaviorism is the observation, prediction, and control of behavior. Hence, given the stimulus, the response can be predicted. Conversely, given the response, the stimulus can be determined. To Watson, the learning process was the process of conditioning. Watson believed, for example, that all infants have reflexes - unlearned or unconditioned responses which are subject to conditioning. It is from the conditioning of these reflexes that learning emerges.

Watson's behavioristic theory of learning was based on the premise that all individuals are alike at birth, responding alike to the same stimuli. More specifically, everyone enters the world similarly equipped, sharing the same responses. From such unlearned behavior, it is possible, by pairing a neutral stimulus with an unconditioned one, to produce a conditioned response; that is, to produce learning and the habits that form one's personality. All behavior is, therefore, explainable in stimulus and response terms.

In effect, Watson endorsed Pavlov's classical conditioning theory and in the process gave scientific credence to the notion of "habit". It is Pavlov's neurological explanation of the conditioning process that differentiates the theories of Watson and Pavlov.

Edwin Guthrie: Association by Contiguity

Contiguity theory, as defined by Edwin Guthrie (1952), signifies that events which occur in close proximity to one another, either spatially or temporally, will tend to be learned because they have been associated with each other. Guthrie used the term contiguity to be equivalent to the principle of association, a concept that dates back to Aristotle. Guthrie theorized that what was associated was a stimulus and a response. Additionally, Guthrie argued that one learns only what one does. Therefore, Guthrie wrote, "teaching consists of inducing by one means or another some desired pattern of movement, whether of the whole body, of hand and eye, or of speech. The movement must be induced in the presence of the stimuli that we wish to make its cues or signals" (1952, pp. 42-43).

In contrast to Pavlov's position that learning does not occur with the first pairing of stimulus with response, Guthrie claimed that conditioning can be established with the first association of a stimulus and a response. In short, Guthrie championed a one-trial association theory of learning which predicates once an association has been made, learning has, in fact, occurred. In short, Guthrie conceptualized that the association between stimulus and response was at full strength the first time it occurred.

Guthrie also introduced the concept of motives to mean "persistent stimuli or organic conditions which create and maintain excitement" (1938, p. 103). Guthrie reasoned that problems serve as motivation because they are "persistent stimulus situations of such a nature that they keep the animal or the person disturbed and excited until some act is hit upon which removes the 'maintaining stimuli' and allows the excitement to subside" (1938, p. 96). Hence, disturbing stimuli drive a person to action, and Guthrie maintained that what is learned is the final act associated with the resolution of the problem.

Edward Thorndike: Connectionism

Edward Thorndike (1940), the founder of learning theory in the United States, has developed a system of learning predicated on Jeremy Bentham's philosophy of psychological hedonism. According to hedonists, individuals by virtue of their human nature, pursue pleasure and avoid pain. Thorndike described his approach to learning in the following manner.

> It is convenient to have a word or words to use in place of the symbol -> or the phrase "has a certain probability of evoking"; and the words connect and connection are so used. So we say that in a person who knows French there is a connection between "roi" and "king," or that the connection between an object approaching the eyes rapidly and the act of closing the eyelids does not require learning, but is a part of man's "original nature" (1940, p. 13).

Thorndike held that an intelligent person and one inferior in intelligence differ only with respect to their connection-forming abilities. In short, the greater the ability to associate ideas the higher the I.Q. Thus Thorndike put forth the hypothesis that quality of intellect is contingent on the quantity of connections or association of ideas. Additionally, Thorndike held that only two things were necessary for predicting behavior: (1) a person's network of mental connections and (2) the situation in which the individual is found. From this position, Thorndike argued behavior is a consequence of learning.

B. F. Skinner: Operant Behaviorism

Skinner's (1950) theory of learning is a reinforcement learning theory. Skinner defined reinforcement in terms of the probability of response. A positive reinforcer strengthens behavior that brings it about while a negative reinforcer diminishes aversive stimuli. More specifically, Skinner defined learning as a change in probability of response. Skinner then sought to discover those conditions producing a response -- that is, the independent variables. For Skinner, the independent variables are the reasons that learning occurs.

In relating his theory to human instruction Skinner wrote, "teaching is the arrangement of contingencies of reinforcement which expedite learning" (1969, p. 15). On programmed instruction, Skinner wrote:

> Programmed instruction is a technique taken directly from the operant laboratory, and it is designed to maximize the reinforcement associated with successful control of the environment. A program is a set of contingencies which shape topography of response and bring behavior under the control of stimuli in an expeditious way (1969, p. 15).

Congruously, Skinner wrote of the teaching machine:

> The teaching machine, like the private tutor, reinforces the student for every correct response, using this immediate feedback not only to shape his behavior most efficiently but to maintain it in strength in a manner which the layman would describe as "holding the student's interest" (1958, p. vii).

Skinner believed that reinforcement is achieved by the machine's shifting to the next problem. This shifting is tantamount to saying "Good work. You did well enough to advance."

Clark Hull: Drive-Reduction Theory of Learning

Clark Hull's (1942) theory on learning differs from other reinforcement theorists in that primary reinforcement is defined as drive reduction. Hull maintained learning occurs only when a response is reinforced and reinforcement transpires only when a drive is reduced. This postulate of reinforcement is Hull's main principle, and his system is essentially a reinforcement theory of learning. Learning, the bonding together of stimulus and response, is responsible for the behavior of both humans and animals.

Kenneth Spence: Incentive Motivation

Kenneth Spence's (1956) Incentive Motivation Theory of learning is a major step away from early learning theorists. Whereas Hull (and earlier theorists) hypothesized a "habit" theory of behavior, Spence introduced an "incentive motivation" theory of behavior. In short, Spence maintained that learning was attributable to a "motivational" factor rather than to a "habit" factor. In order to prove that incentive was a factor independent of drive, Spence conducted a number of experiments. In describing his experimental findings, Spence noted:

> ...performance ... was a function of the magnitude of the incentive,... a drop in level of performance occurred if a smaller piece of food was used. Similarly, a shift to a larger piece of food was shown to lead to improvement in performance. These shifts up and down seem to me to suggest changes in a motivation rather than a habit factor (1956, p. 134).

In developing an incentive motivation theory based on the Hull-Spence approach, Logan and Wagner (1965) defined total motivation as the product of incentive motivation and drive. Logan and Wagner, in developing their incentive theory, sketched a comparison between expectation and incentive. To Logan and Wagner, expectation is that reward or punishment which results from a certain behavioral response. In contrast, habit learning is contingent upon the contiguity of a given response to a given stimulus (S-R connection) without regard for the incremental or decremental properties of reward or punishment. Incentive learning (or at least performance) is strengthened or weakened by increments and decrements in rewards and punishments. When incentive is absent, an individual does not perform as well. According to the Logan-Wagner hypothesis,

> Incentive learning (sINr) refers to a learning process that depends directly upon special incremental and decremental effects on performance that are produced by reward and punishment respectively. The presumption is that a stimulus-response-reward sequence produces positive incentive, that a stimulus-response-punishment sequence produces negative incentive, and that the tendency for a stimulus to elicit a specified response depends in part upon the net incentive value associated with that response (1965, p. 26).

Logan and Wagner argued incentive motivation determines when and how responses are made. A high level of incentive causes a high level of performance. In short, once motivated, people do respond, and once they respond, they do learn.

Neal Miller: Drive-Cue-Response-Reinforcement Theory

Embracing the assumption that human behavior is learned, Miller (1941) identified four elements of learning: (1) drive, (2) cue, (3) response, and (4) reinforcement. Drive impels an individual to act, thus producing some kind of response. Although a stimulus is required, a drive can serve as a stimulus. Drives are of two types: (1) primary and (2) secondary. Primary drives are innate while secondary drives are learned.

Cues or stimuli determine when, where, and to what a response will be made. Just which response is called for depends on the available cues.

A behavioral act is a response to certain cues propelled by a drive. For Miller, response is a necessary condition to learning, as learning occurs when an individual responds in a novel manner. A correct response is vital to reward, with the rewarded response increasing in frequency as a function of reinforcement.

Reinforcement is any event which strengthens the probability that a response will recur. Mere repetition does not necessarily strengthen the probability of response reoccurrence as an unrewarded response will perish.

Using these four fundamentals of learning, Miller has developed a reinforcement theory of learning whose basic assumption is that a sudden reduction in a potent drive serves as a reinforcement. Miller and Dollard summarize their theory in the following manner:

> Four factors are essential to learning. These are: drive, cue, response, and reward. The drive stimulus impels responses which are usually channelized by cues from other stimuli not strong enough to act as drives but more specifically distinctive than the drive. If the first response is not rewarded, this creates a dilemma in which the extinction of successive non-rewarded responses leads to so-called random behavior. If some one response is followed by reward, the connection between the stimulus pattern and this response is strengthened, so that the next time that the same drive and other cues are present, this response is more likely to occur. Since rewards presumably produce their effect by reducing the strength of the drive stimulus, events cannot be rewarding in the absence of an appropriate drive. After the drive has been satiated by sufficient reward, the tendency to make the rewarded response is weakened so that other responses occur until the drive reappears (1941, pp. 35-36).

<u>Edward Tolman: Purposive Behaviorism</u>

In his major systematic work, <u>Purposive Behavior in Animals and Men</u> (1932), Edward Tolman labels his learning theory purposive behavior. In this classic publication, Tolman argues behavior is best described in terms of action with a purpose and goal. For Tolman, it is the achievement of some goal or end state, not the sequence of muscle twitches bringing that goal about, which is the unit of analysis.

The question of whether behavior should be described in terms of purposes or in terms of movements is called the molar (large-scale) as opposed to the molecular (small-scale) issue in learning theory. Tolman clearly advocated molar descriptions of behavior. Tolman argued for a view of humans and animals that emphasizes the organism's deliberative reflections about problems, its internal representations of the environment, and its sense of how these representations can be used to solve problems. It is somewhat surprising that Tolman looked for evidence of such cognitive processes in rats, the subjects of nearly all his experiments, rather than in humans.

Tolman (1948) believed that an animal's knowledge about an environment came to be organized into a cognitive map of the environmental area rather than a simple unconnected list of local stimulus-response pairs. He summarizes this organization of knowledge in the following way:

> (The brain) is far more like a map control room than it is like an old-fashioned telephone not connected by just simple one-to-one switches to the outgoing responses. Rather, the incoming impulses are usually worked over and elaborated in the central control room into a tentative, cognitivelike map of the environment. And it is this tentative map, indicating routes and paths and environmental relationships, which finally determines what responses, if any, the animal will finally release (1948, p. 192).

Cognitive and Information-Processing Theories of Learning

Cognitive psychology has been concerned with how organisms cognize -- gain knowledge about -- their world, and how they use that knowledge to direct decisions and perform effective actions. Cognitive psychologists (e.g. Tolman, Piaget, O'Neil, Bower) try to understand the "mind" and its abilities or achievements in perception, learning, thinking, and language use. To this end, they postulate theories about its inner workings.

Information-Processing Learning Theories

A number of cognitive psychologists have followed the information-processing approach to learning, viewing the human brain as a kind of computer. The concept of this process was introduced by Tolman (1948) and was favored over those processes advocated by behaviorists who explained learning dualistically (stimulus-response). Information-processing theories are contrasted with stimulus-response theories in that the former imply behavior as resulting from events transpiring within the individual so that behavior is contingent on cognitive processes. Stimulus-response theories, on the other hand, intimate that behavior is controlled externally by the stimulus and hence is subject to stimulus control.

Newell, Shaw, and Simon: Information-Processing Theory of Learning

Newell, Shaw, and Simon (1958) have developed an information-processing theory of learning which views a human as a processor of information. These three researchers sought to use computers to simulate human information processing and problem solving while recognizing the limited similarities between computers and humans.

> ... we are not using the computer as a crude analogy to human behavior -- we are not comparing computer structures with brains, nor electrical relays with synapses. Our position is that the appropriate way to describe a piece of problem-solving behavior is in terms of a program; a specification of what the organism will do under varying environmental circumstances in terms of certain elementary information processes it is capable of performing. A program is no more, and no less, an analogy to the behavior of an organism than is a differential equation to the behavior of the electrical circuit it describes. Digital computers come into the picture only because they can, by appropriate programming, be induced to execute the same sequences of information processes that humans execute when they are solving problems (1958, p. 153).

Information processing is computer simulation. It is a description of the mechanistic function of digital computers from the time the input information is fed into them through the internal processes to the output stage of a printed readout or screen readout . Applied to learning theory, information, the stimuli read into the system, is the input (the data or instructions). The output or readout would constitute the response stage. The computer, during a process interspersed between the input and output stages, is characterized as executing a sequence of instructions. The information is fed into the computer during the input stage. Hence, a computer program affords a program analogy of human information processing.

Jean Piaget: Cognitive Developmental Theory of Learning

Piaget (1932) theorized that children organize their world in characteristic ways corresponding to their age. He identified four major stages of cognitive development, which he claimed reflect biological maturation as well as increasing social experience. Progressing through these stages, the child not only learns an increasing amount of information, but also comes to organize knowledge in new and different ways.

The first stage of human development in Piaget's model is the sensorimotor stage -- the level of human development in which the world is experienced only through the senses in terms of physical contact. In this stage, which corresponds roughly to the first two years of life, the infant explores the world through touching, sucking, and listening. The second stage described by Piaget is the preoperational stage -- the level of human development in which symbols, including language, are first used. The preoperational stage typically corresponds to the years between two and seven. For Piaget, the ability to use symbols implies children can experience the world mentally -- that is, they can conceive of something without having direct sensory contact with it. The third stage in Piaget's model is the concrete operational stage, the level of human development characterized by the use of logic, but centered on reality rather than on alternatives. Within this stage, which typically corresponds to the years between seven and eleven, children make significant gains in their ability to comprehend and manipulate their environment. They begin to think logically, connecting events in terms of cause and effect. The fourth stage in Piaget's model is the formal operational stage -- the level of human development characterized by highly abstract thought and the ability to imagine alternatives to reality. Beginning at about the age of twelve, children have the capacity to think of themselves and the world in highly abstract terms rather than only in terms of concrete situations.

Although Piaget was aware that the content of learning -- language, values, norms -- is not the same from culture to culture, his theory suggests humans everywhere progress sequentially through the four stages which he detailed.

Cognitive Style

Just as behavioral and cognitive theorists have formulated a multiplicity of models in investigating and elaborating on how individuals "know," so too have learning stylists fashioned different templates for organizing their positions on individuals "preferred methods of knowing." Each has formed a unique perspective from which to explain how individuals learn.

The term "cognitive style" was coined by Gordon Allport in 1937 to refer to a quality of living and adapting influenced by distinctive personality types (Keefe, 1979). Since that time, researchers have attempted to refine the definition of the concept. Messick (1970) defined cognitive style as representing a person's typical modes or habits of processing information by perceiving, thinking, remembering, or problem solving. Cross (1976) viewed cognitive styles as characteristic ways of using one's mind. Ewing (1977) explained cognitive style as the application of a person's preferred approach to all problems, as if superimposing a template or a pattern onto all problematic situations. In sum, cognitive style refers to how a person behaves in situations and not to the components of the behavior. Cognitive styles are distinct from, but related to, abilities which deal with the content of the cognitions, and are more associated with general intelligence, scholastic ability, IQ, and even aptitude (Messick, 1976).

Learning Style

Although similar in many ways to cognitive styles, learning styles occur in a context that is more specific -- "the context of learning" (Claxton & Ralston, 1978). However specific the content, it is still wide enough to encompass the personally preferred ways of "dealing with information and experience for learning that crosses content areas" (Della-Dora & Branchard, 1979, p. 22). Hunt (1979) viewed learning style as a term referring to the process by which students learn, not the content of what a student learns. Gregorc (1979) asserted that learning styles emerge from innate predispositions which individuals relate to the world, and result in distinctive and observable behaviors that are persistent in even diverse situations.

Learning styles and cognitive styles share some similarities and show some differences. While cognitive style is considered to be primarily bipolar in dimension (Witkin et al., 1977), learning style usually involves many more elements (Kirby, 1979). For example, by focusing on just one cognitive style dimension with dichotomous extremes, the presence of one extreme (field dependent, for example) excludes the presence of the other (field independent). With learning styles, it is not such an "either-or" proposition. The presence or absence of one element does not imply the presence or absence of another. With more complex learning profiles and matrices possible, learning styles are thought to have greater heuristic value to the educator, though probably less descriptive of the basic cognitive activity taking place.

"Learning style" seems to have emerged as a more prevalent term in the 1970's, and those working under the rubric of "learning style" tend to consider cognitive style as more of an underlying construct (Kirby, 1979). Learning style devotees have shown more interest in the practical educational and training applications, and, as such, are more action-oriented. The similarity between cognitive style and learning style may be due more to a partial overlap of domains than to a confusion in identity. Dunn, Dunn, and Price (1979) viewed cognitive style as synonymous with only selected elements of learning style. They interpreted cognitive style as the psychological subcategory of individual differences that comprise but one element of learning style. Keefe (1979) agreed that cognitive style and learning style are not the same because learning style incorporates affective and physiological components as well as psychological. Learning style is a blend of cognitive, affective, and physiological styles where affective styles are the learner's typical manner of arousing, directing, and sustaining behavior; and physiological styles are biologically-based modes of response.

Hill's Cognitive Mapping

In one of the first attempts to integrate the different strands of earlier cognitive style, educational, and psychological research, Hill (1981) developed a technique known as "educational cognitive mapping". The basic principle of Hill's strategy was to match each student's "cognitive map" to the learning resources of the institution. Hill described his model under a framework he refers to as the "seven educational sciences". These he arranged in a hierarchy in which each "science" benefited from and embraced the previous level. Hill and Nunnery (1973), in developing their educational sciences, defended education as a search for meaning. Specifically, they maintained that thought is different from language; that as a social being, man makes meaning from his environment and personal experience through the use of symbols; and that biological satisfaction alone never lessens man's search for meaning.

The seven sciences include (1) symbols and their meanings, which are considered basic to the acquisition of knowledge and meaning; (2) cultural determinants that affect what the symbols mean to particular individuals; (3) modalities of influence which describe how individuals make inferences; (4) neurological, electromechanical, and biological aspects of memory; (5) cognitive style which is the product of the previous four; (6) teaching, administrative and counseling style; and (7) systematic analysis decision making.

Hill's model was designed to provide students with an understanding of their educational cognitive style so that they could more effectively plan for their own learning. However, his main purpose was to match learners with learning environments, and he planned five learning modes by which each course was to be taught: traditional lecture, individual programmed learning, audiotape, videotape, and group seminars with peer tutors (Knaak, 1983).

David Kolb: Experiential Learning Theory

In his book, Experiential Learning: Experience as the Source of Learning and Development (1984), David Kolb presented an intriguing theoretical framework on learning style which advocates active participation in the learning process. In formulating his model, Kolb (1984) drew from three primary sources. Specifically, his theory embraces the work of Dewey (1958), who recognized the importance of experience in learning; the work of Lewin (1951), who emphasized active participatory learning, and the observations of Piaget (1958), who conceived of intelligence as largely the result of individual experiences. Kolb's model of action research and laboratory training views learning, growth, and change as being facilitated by an integrated process that begins with here-and-now experiences followed by observations, reflections and data collection about the experiences. The data are analyzed and then shared with others so that behavior can be modified and new experiences chosen. Thus, for Kolb (1984), learning can be defined as the process whereby knowledge is created through the transformation of experience. Using this definition, Kolb emphasized the process of adaptation and learning rather than content or outcomes. He maintained that knowledge is continually created and recreated by the learner, and he viewed this as a process rather than as a product to be acquired or transmitted.

Kolb pictured the learning process as involving four modes: concrete experience, reflective observation, abstract conceptualization, and active experimentation. In following Kolb's model, a learner begins with a concrete experience (CE) and all the affect that accompanies it; then moves to a point of making observations about that experience and reflecting upon it. From these observations and reflections (RO), one can form theories about what was experienced, via abstract conceptualizations (AC) . The learner then tests these ideas in a new situation, the active experimentation mode (AE). According to Kolb, learning is a holistic process of adaptation to the world. It involves the integrated functioning of the total organism -- perceiving, feeling, thinking, behaving.

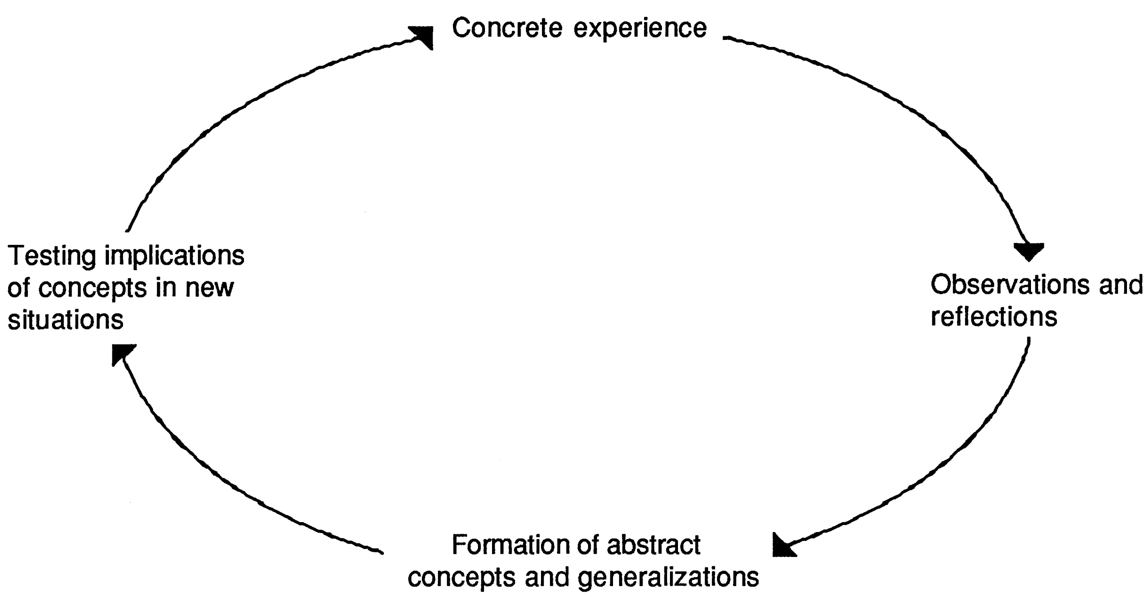

Figure 1. Kolb's Experiential Learning Model

Daryl Bem: Self-Perception Theory

In his research on the development of self, Daryl Bem (1967, 1972) held that people infer their own attitudes and motivations by observing their own behavior and the context in which it occurs. Restated, when there is no apparent source of reinforcement external to the stimulus, people infer their attitudes about their behavior from the properties of the stimulus. For example, if a child is continually encouraged to read by his/her parents or teacher, and is reinforced for doing so, he/she is likely to attribute the behavior and resultant attitude toward reading to the teacher or parents. If, on the other hand, that same child finds him/herself reading and the teachers/parents do not make a "big deal" of it, the child is likely to infer from the behavior that reading is something he/she likes. For Bem such inferences form the basis for intrinsic motivation. In short, Bem held that promises of valuable rewards as well as threats of severe punishment will prevent an individual from inferring attitude from his/her own behavior. This, then, inhibits the development of intrinsic motivation as the individual will tend to attribute his/her interest in an activity to the extrinsic reinforcement.

Edward Deci: Cognitive Evaluation Theory

Edward Deci (1975), in his cognitive evaluation theory, suggested that intrinsic interest in an activity is directly related to feelings of competence. In short, he maintains those factors that make people feel more competent at some activity will heighten their intrinsic interest.

Bandura: Self-Efficacy Theory

Bandura's (1977) theory of self-efficacy proposes that beliefs about one's ability to perform a given behavior successfully and thereby bring about desired consequences are an important source of motivation. According to Bandura, people are more likely to engage and persist in those activities for which they have high expectations of personal efficacy rather than in those activities at which they believe they will fail. Bandura also made a case for self-regulation of behavior through self-reinforcement. His research has shown that self-reinforcement procedures can be at least as effective as the typical procedure in which another person (for example, teacher) sets goals for the learner and delivers the rewards.

Erik Erikson: Facilitative Environment and Learning

Erik Erikson (1963), a psychosocial theorist, suggested five characteristics that constitute what he labels a "facilitative environment" -- an environment that will enhance the growth and development of the individual: (1) experimentation with varied roles, (2) opportunity to make choices, (3) experiencing meaningful achievement, (4) freedom from excessive anxiety, and (5) opportunity for reflection and introspection.

Papert: The Role of Participation and Individual Discovery in Learning

Seymour Papert (1980) effectively argued that true learning involves active participation and individual discovery. To propel this process, he created simulations or microworlds designed to promote more active, inductive, or discovery-based learning. Computers, for example, provide a learning environment in which children can discover principles identifiable in all areas of traditional learning. Knowledge acquired through discovery is then integrated into the individual's cognitive framework, making it relevant, useful, meaningful, and personal.

Implications Derived from Learning Theories

Each of the theoretical positions discussed lends basic support to the notion that active participation is an important part of the learning process -- whether in mind (cognitive) or in body (S-R theory). According to Bem (1967, 1972) and Deci (1975), such involvement serves to motivate the individual and to raise his/her level of confidence. In other words, by virtue of the activity, learners are also dealing with self-identity, attitudes, and a sense of self-worth. Additionally, if the classroom environment is a facilitative one as defined by Erikson (1963), then such experimentation with varied roles and the experience of choice, combined with the opportunity for reflection and introspection, can culminate in meaningful learning experiences by those participating.

Experiential learning described by Kolb (1984) and others (e.g. Papert (1980), Piaget (1932, 1958)) provided a framework from which educators can actively engage learners in the process of creating knowledge, integrating concepts, and evaluating both what is and what could be. Certainly, as Bem's, Erikson's, and Deci's theoretical views would imply, this kind of learning is much richer and more meaningful than is the passive learning which currently characterizes the traditional classroom.

The "experiential learning" model is not the model of the traditional classroom. On the contrary, it suggests a radical departure from the traditional classroom structure. However, the principles of "experiential learning" are already at work in at least two alternatives to the traditional classroom -- the free school and the open classroom (Stretch, 1970). Free schools are private schools usually formed by parents who are willing to pay tuition because of their objection to impersonal, bureaucratically run public schools. The basic purpose of free schools is to encourage student input into the planning and running of school programs. In open classrooms, the emphasis is on individual progress instead of competition, and students are less likely to be frustrated by repeated failure. In short, open classrooms encourage individual initiative and creativity instead of passivity and rememoration.

While both free schools and open schools still operate within this society today, their success has been at best tenuous. Bennet (1976), in comparing traditional and nontraditional schools, demonstrated that on conventional achievement tests students in traditional schools usually do better than students in nontraditional schools. In marked contrast, Silberman (1971) demonstrated the superiority of nontraditional schools in such areas as spoken and written English, art, ingenuity, nonschool interests, critical thinking, initiative, and desire to learn. In addition, Silberman also identified a number of noncognitive gains in nontraditional schools including increased self-confidence, spontaneity, and openness to new experiences.

One of the most extensive reviews of research on the nontraditional versus the traditional classroom has been conducted by Horwitz (1979) who concluded that findings comparing these two types of schools are at best mixed. In general, Horwitz's (1979) findings indicated that nontraditional and traditional classrooms have about the same percentage of studies showing their superiority in academic achievement. However, most studies, he reported, demonstrate either mixed results or no significant difference between these two approaches. In contrast, while the results concerning academic issues are mixed, the results concerning non-academic issues are much more definitive. Specifically, the nontraditional classroom clearly outperforms the traditional classroom in such non-academic areas as self-esteem and attitudes towards school, creativity, and curiosity.

Perhaps the biggest problem with free schools and open classrooms today is that they offer a solution which is viewed by most as too extreme. While few would disagree change in the educational structure is needed, most would insist such change be incremental and moderate. In contrast to the free and open classrooms, a classroom structure incorporating computer assisted instruction offers a compromise between the extreme of the traditional classroom on the one hand and the free or open school on the other.

Review of Empirical Literature on Computer Assisted Instruction

In discussing the role of computers within education Hill (1983) noted:

> Problem solving ability and higher-order cognitive skills have always been among the educational goals, but the computer provides a unique tool to aid in the solution of problems. Thus learning to communicate with and through computers, and learning to command their services in meeting human needs become essential new goals of our school program (p. 14-15).

Congruent with numerous learning theories, the critical factor which seems to distinguish the computer from such media as books, lectures, and films is <u>its potential for high levels of interaction</u>. In Bork's (1984) words:

> For the first time since we could afford individualized tutoring for all education, we now have the possibility that learning can be an active experience for almost all students. This factor alone establishes the importance of the computer for education (p. 1).

Put another way, conceptual development builds on actions. For a child's mind to grow, he/she must be involved physically and mentally. A computer provides both physical and mental involvement.

The Department of Elementary Education at Ball State University operates a Living-Learning laboratory for young children (Williams, 1984). Faculty and students use this program in their studies of the interaction between children and computers. From this study, three important conclusions emerged. First there was no significant difference in the frequency of computer use between boys and girls. Second, the children knew colors and shapes in situations removed from the computer, suggesting a transfer of knowledge. Third, there were social outcomes such as helping behavior, turn-taking, and sharing. In short, the findings clearly suggested that children who interact with a computer in a learning environment experience physical, social, and cognitive growth.

There is increasing support in the field of education for computer assisted instruction, and this support, in part, appears to be a function of the growing body of evidence demonstrating its effectiveness in the learning process. Jelden (1980) , for example, found that the incidence of computer assisted instruction correlates positively with students' grades. Similarly, Kulik (1980) has noted that computer-based education has generally had positive effects on the achievement of elementary school pupils. VonFeldt (1977) has also confirmed the positive influence of computer assisted instruction upon student achievement, and has identified auxiliary advantages including the computer's ability to interest students of all ages, the computer's use of immediate feedback which accelerates the learning process, and the easy modification of computer assisted instruction lessons for other applications. Likewise, Humphrey (1982) in her survey on children's impressions of personal computers, observed the unmistakable ease with which children have incorporated these machines into their daily lives. Humphrey characterizes students as enthusiastic, confident, and creative users.

In a provocative study by Molnar (1981), a researcher who compiled the results of 59 independent computer-based instruction studies, computer assisted instruction instruction produced significantly better results than conventional methods of instruction. Specifically, a typical student participating in a computer-based course achieved scores 10 to 15 percent higher than those achieved by students in traditional learning environments. Molnar reports that the results were the same for students at all levels of proficiency. Molnar also reports that computer assisted instruction instruction inspired greater interest among students in their courses, an absolute prerequisite Bem's and Deci's theories would suggest, if learning is to improve. Moreover, computer assisted instruction students learned the course material in two-thirds the time that it took students who relied strictly on conventional methods. In short, computer assisted instruction instruction, when compared to conventional methods, was faster, resulted in higher scores, and was better received.

Congruously, Neimiec and Walberg (1985) statistically examined the findings of 48 published studies on computer assisted instruction in elementary education and concluded computer assisted instruction is indeed an effective means of raising student achievement scores. Additionally, these researchers found that (1) lower achieving, exceptional and younger students achieved more than others; (2) boys achieved more than girls; and (3) that drill and practice was the most effective form of computer assisted instruction. In short, it was found that the success of computer assisted instruction does not appear to be limited to a single academic area but rather spans a diverse number of subjects including mathematics, computer literacy, handwriting, writing, and reading skills.

The Literature on Mathematics

In many ways the field of mathematics is logically and naturally linked to computers since computers themselves are built on mathematical principles and even uses the language of base two. This natural link would suggest that the computer is a viable medium for learning mathematics and this premise is supported by a growing body of empirical findings.

Big Trak (Swada, 1984) is an impressive example of how children have been introduced to computers. Big Trak is a six-wheeled robot which consists of a control panel that is very basic. Children take great interest in Big Trak because they view him as a toy. In many ways, Big Trak becomes an extension of the child's mind. Specifically, Big Trak allows a child to actually see his/her thoughts in action and to record the actions in a log book which can be examined and used to plan future activities. Because Big Trak does what it is instructed to do, there is a valid correspondence between that which Big Trak does and that which the child has told it to do. Big Trak has been shown to be a tremendous asset in teaching mathematical concepts to young children.

Clarke (1985/86) conducted a pilot study designed to assess the influence of a Logo learning experience on children's attitudes toward mathematics and general ability. Her sample consisted of 43 first, third, and fifth grade girls. Before computing activities were introduced into the curriculum, the girls completed two standardized tests: (1) the Otis-Lennon (1979) School Ability Index Test (SAI) which is a general ability measurement yielding standardized deviation intelligence quotients, and (2) Hogan's (1975) Survey of

School Attitudes (SSA) which provides percentile scores representing children's interest in learning about mathematics, science, social science, and reading. During the school year the girls had two, 20-minute computing classes per week in which they used Logo turtle graphics for three types of activities: worksheets, games, and free exploration. At the end of the school year, the girls completed the parallel forms of the SAI and the SSA. Findings show that the girls experienced a significant increase in their mean SAI score and a significant increase in their mean percentile scores for attitudes toward mathematics.

Stoneburg (1985) evaluated the effects of computer assisted instruction in mathematics as delivered by the WICAT system 300 in an elementary school. Evaluation activities were designed and conducted to determine whether the participants felt that computer assisted instruction improved elementary math achievement. Major findings indicated that achievement scores improved significantly with the most dramatic improvements occurring among students in the second grade.

Sigurdson and Olson (1984) conducted a quasi-experiment addressing the effectiveness of computers in improving math achievement. Their study involved two groups: a project school and a control school. In the project school microcomputers were used by seven teachers in grades two through six. One microcomputer was placed in each classroom for one-half day every day for a full school year. Teachers were asked to use the computer at least 70 percent of the time for practice in mathematics. The remaining 30 percent of the time was spent in learning computer literacy, logic games, or language arts. In the control school, students were taught math and language arts skills in the traditional manner. Sigurdson reported that students' and teachers' reactions to the computer were quite positive. Over all, the effect of math achievement favored the project group over the control group.

Litman (1973) described a computer assisted instruction system that has been implemented in 21 elementary schools in the Chicago area. The system runs on a UNIVAC 418 III which processes concurrently the reading, language arts, and math drill practice strand programs of the Computer Curriculum Corporation. All students participating qualified under the Elementary and Secondary Act Title I guidelines for compensatory education, and all were achieving at least one year below grade level upon entering the program. Results of the project after the first year showed it to be highly successful. More specifically, students showed gains to nearly one month for each month in the program -- a figure substantially better than the national average for compensatory education students which stood at 5.6 months for every eight months of instruction. In effect, the computer provided individualized instruction and thus freed the teachers from drill activities for more creative work.

Delforge and Bloeser (1981) also studied the influence of computer assisted instruction on math scores. In their study, students, who were in the lower 45 percent of a class in math achievement, were exposed to computer assisted instruction for ten minutes daily. Students in the upper 55 percent were exposed to computer assisted instruction for 10 minutes weekly. The findings demonstrated that those students making daily use of computer assisted instruction experienced significant improvement in math as measured by the Iowa Test of Basic Skills Math Sub-test. Additionally, when compared to those students participating weekly in computer assisted instruction, those students participating daily had greater math gains.

Davis (1980) also demonstrated the influence of computer assisted instruction on math abilities. Approximately 60 PLATO/WICAT terminals were installed in elementary school classrooms with four terminals per classroom. Each student received 30 minutes of math lessons each day. Davis reported that those students using the computer demonstrated significant gains in math. Additionally, those students using the computer displayed more positive attitudes toward mathematics in general.

Winner and McClung (1981) also observed the value of using computers to teach mathematics to fourth and fifth graders. Computers were placed in fourth and fifth grade classrooms, and these researchers observed classroom activities over a three-year period. Their findings revealed that computer games were especially helpful in teaching math concepts. The authors noted that over their three years of observation, the atmosphere of the math classes changed considerably. In fact, when children were given the opportunity to use the computer, their inhibitions toward mathematics diminished. In short, these authors conclude that the success pupils experience in math when using computers allows them to attempt mastery of skills previously rejected and to attempt understanding of concepts previously thought too difficult.

Endreweit (1985) also attested to the value of computers in teaching math. He noted that besides the improvement of individualized skills, computers can provide challenging programs that respond to children's personal interests. Additionally, he suggested that computers serve to increase motivation. In short, most children seem willing to work harder on the duller learning tasks when they can do them on the computer. The positive influence of computers on learning mathematics has been corroborated by Hatfield (1985) who noted that mathematical abilities can be improved both through the use of BASIC computer programming and through the use of drill and practice.

The Literature on Computer Programming

Logo, a computer language adapted for use on several different microcomputers, has recently been used to facilitate the introduction of young children to computers and computer programming. The language contains a number of features (including graphics) that are intended to make it potentially understandable to every young child. In its most well-known current use with children, Logo is designed to provide the novice user with access to a programmed micro-world known as "turtle graphics." In this mode of operation, children are taught to write programs that control the movements of a cybernetic "turtle" (a triangular cursor displayed on a monitor), enabling this turtle to make drawings on the screen. Knowledge of only a half-dozen commands (e.g. forward, backward, left, right) permits the child to produce large and exciting graphic effects. By putting themselves in the turtle's place, children learn to design and debug their own programs.

As a programming language, Logo has added to the computer's success in the classroom. As previously noted, Clarke (1985/86), explored the use of Logo to teach mathematical concepts. She measured attitudes towards math and math ability both before and after using Logo. Her findings suggested that the Logo experience had a decided positive effect on both general math ability and on expressed interest in learning mathematics.

In a study evaluating the creative use of computers in elementary schools and their impact on students' confidence and self-esteem, Carmichael (1985) investigated 433 students in 18 classrooms over a two-year period. Each classroom had between one and five computers, or students had access to a computer laboratory. Logo was studied extensively. Findings indicated that the creative use of computers fostered the development of original thinking and that an environment that encourages exploration lead to extensive social interaction among students.

Dale (1984) conducted a 10 week project with 12 gifted fourth and fifth graders (10 boys and 2 girls). This project was designed to examine the effectiveness of the Logo computer programming language as a tool for helping students understand some basic principles of physics. Three assumptions were tested: (1) motivated elementary school students can learn both turtle graphics and word and list manipulation; (2) Logo provides a motivating environment for learning the ideas and concepts of physics; and (3) Logo makes the basic principles of physics understandable. Results indicated students mastered the Logo commands and concepts required for the physics objects, found word and list manipulation surprisingly easy, and found learning physics with Logo extremely interesting.

Battista and Steele (1984) assessed the effects of two commonly used types of computer-based instruction, computer assisted instruction and computer programming instruction, on the feelings and knowledge students have about computers. Using the California Short-Form Test of Mental Maturity, 87 fifth graders were placed within either a control group or a computer assisted instruction group based on intellectual ability. Computer literacy was measured by the Minnesota Computer Literacy and Awareness Assessment. The computer assisted instruction group used the "Math Sequence" program while the control group used the "Singer Individualized Mathematics Drill and Practice Kit." Findings indicated that the computation scores of the computer assisted instruction group improved significantly more than those of the control group. Additionally, the computer assisted instruction group showed a significantly greater gain than the control group in both the affective and cognitive domains of computer literacy. In effect, the findings suggested interacting with a microcomputer for drill and practice in mathematics increased students' knowledge about computers even though no explicit discussion of computer topics is presented by teachers.

In a second study, Steele, Battista and Krockover (1984) again investigated the effects of two commonly used types of computer-based instruction, computer assisted instruction and computer programming instruction, on the feelings and knowledge students have about computers. The subjects for this study were 72 fifth grade students taken from three midwestern elementary schools. Students were tested using the California Short-Form Test of Mental Maturity. On the basis of I.Q. scores, the top 48 students were divided into the computer assisted instruction and control groups. The remaining 24 students comprised the computer programming group. The computer assisted instruction group used "Math Sequences" while the control group used the "Singer Individualized Mathematics Drill and Practice Kit." The computer programming group spent most of their time working at the computers in pairs in order to create graphic displays and run and alter prewritten programs. Findings indicated that both treatment groups (computer assisted instruction and computer programming) improved in computer literacy in the affective domain, but only the computer assisted instruction group improved in computer literacy in the cognitive domain.

Huber (1985) also demonstrated the effectiveness of Logo as a facilitator of cognitive growth. Additionally, the effectiveness of Logo as a facilitator of computer literacy was demonstrated by Kinzer (1985). These findings corroborated those of Lawler's (1982) case study of an eight-year-old boy learning Logo. In short, Lawler submited that the power of the computer in education can go well beyond the "traditional" role of drill-and-practice and game playing.

The Literature on Handwriting

Furner (1985) explored the use of microcomputers to teach handwriting to elementary-aged children. Her findings point to the value of microcomputers in this teaching area. In short, she concluded that carefully designed computer-based programs of instruction can be of value for some, if not all, learners. This finding substantiated that of Teulings (1979) who demonstrated that through the use of digital computers, pen movement may provide information for the investigation of motor control in the self-paced movements involved in handwriting.

The Literature on Writing Skills

Smith (1985) demonstrated the effectiveness of word processing in improving writing skills. The process, which she reported is highly motivating for both teachers and students, begins with children dictating stories as the teacher enters them on the computer. Gradually, students are allowed to write the stories themselves. Her findings firmly suggest that if a microcomputer is available to teachers of reading or writing, a word processor is a necessity.

Willer (1985) also examined the influence of word processing on writing skills. His observations revealed improved attitudes toward writing in general and an increased interest in this activity on the part of students.

Bruce (1984) investigated the impact of QUILL, a word processing program, on the writing skills of sixth graders. His findings indicated that programs like QUILL can enhance the learning of both reading and writing by providing new techniques for teaching and learning. Additionally, such programs can also produce profound positive changes in a classroom's social structure.

Aumack (1985) verified the value of word processing in the acquisition of writing skills. In this study, two computer labs were set up -- one for third graders and one for remedial sixth through eighth graders. Third graders used their lab to begin learning basic computer skills. The remedial sixth through eighth graders used their lab to write using a word processing program. Aumack reported that over a two year period, approximately 250 of the school's 900 students benefited from the word processing lab whose 13 terminals and 4 printers were in constant use. Aumack noted the word processing lab produced children who want to write -- even with a pencil and paper. Additionally, he notes, since children who write more read more, all language arts skills improve.

Congruously, Newman (1984) extolled the superiority of word processing programs over drill and practice for teaching writing skills. Similarly, Hennings (1981) has strongly advocated the use of word processing for teaching writing skills. Daiute (1985) also applauded the use of word processors to teach writing skills, and has noted especially their communication capacity which can be used to enhance the writing process. Similarly, Branan (1984) supported the microcomputer environment as one which builds writing skills. She concludes computers can be used to make the task of writing less forbidding to students.

Newkirk (1984/85) also endorsed the usefulness of computers in teaching writing skills. Specifically, he elaborated on the parallels between writing in English and in Logo and the ways in which awareness of these parallels can improve writing skills.

The Literature on Reading

There is growing evidence that computer assisted instruction produces significantly better results with respect to reading skills than conventional methods of instruction. However, the majority of this evidence is based on the impressionistic views of the instructor over an extended period of time. For example, Wheeler (1985), in discussing the influence of a word processor on writing skills, noted word processing is a primary and positive benefit to writing and reading skills. Her position is based on her impressionistic views of students over the course of a school year. Specifically, she suggested that with word processing, students have a record of each of their drafts -- a concrete reminder of the writing process. By studying their old drafts, they can make discoveries about problems in their writing. As a result, Wheeler noted, many students had an improved attitude toward writing and reading even when they were not using the computer.

Congruously, Clemens (1983) demonstrated, through the use of case study observations, that the use of microcomputers in the kindergarten year can help to reinforce reading skills. In fact, such reinforcement will often move a child to a reading level that is beyond grade level. Similarly, Zucker (1982) reported that reading teachers in grades three through six in his school found the computer beneficial in improving reading skills. Likewise, Endreweit (1985) reported that children's interests in spelling and vocabulary improve with the use of a computer. Children are willing to spend more time on spelling and vocabulary when the computer is part of the learning process.

The findings presented here clearly communicate the positive influence of the microcomputer on reading skills. However, the extent to which microcomputers are responsible for the acclaimed benefits cannot be objectively determined from impressionistic data.

There is some empirical evidence which corroborates the findings of these impressionistic studies. In a pilot study using computer assisted instruction at an elementary school in Ohio, sixth grade students gained an average of 2.4 months in reading proficiency during the months they used the computer (Bath Elementary School, 1979). All 100 students used the computer for 20 minutes daily either for remediation or enrichment. Most of these students became faster, more careful readers after using the computer. According to the teacher, the terminals' best asset was the immediate feedback that prevented the students from practicing a mistaken method of operation.

Congruously, Donahoo (1986) reported use of the PLATO/WICAT computer system in a Chicago school for one class at each grade level from kindergarten through grade eight resulted in significant gains at every level on the 1985 Iowa Test of Basic Skills, even though less than a third of the students in the school were exposed to the computer for periods of four to seven months. Donahoo also notes a side benefit of the system is the positive affect on the part of students' feelings for the computer. One teacher, for example, reported students who missed school in the morning came in the afternoon because they didn't want to miss using the computer.

McNinch and Hall (1985) examined the use of word processing to improve reading comprehension. Their findings confirm word processing can be effectively used for the creation and application of practice materials in reading. Congruously, Atkinson (1970) examined the computer assisted instruction program designed at Stanford University which has been used by children in kindergarten through grade three. The program is an adjunct to classroom instruction, stressing the decoding aspect of reading and leaving the communication aspect of reading to the teacher. Atkinson concluded computer assisted instruction is a feasible and economical way to raise the national level of reading. Additionally, he notes computer assisted instruction can free the teacher for more creative types of instruction.

Barnett and Better (1984) demonstrated that incorporating a programmable robot into an elementary school curriculum improves students' speaking, reading, and writing skills. Additionally, Caster (1983), in a review of recent literature, reported that the majority of published studies clearly demonstrate computer assisted instruction in language arts teaching is more effective than traditional methods for teaching reading, vocabulary, and language arts skills.

Summary

While the research findings on computer assisted instruction present quite positive results, studies to date have been based largely on either impressionistic views or on a pre-test-post-test one group design. While these designs are legitimate methods of collecting data, they do not allow for the control of extraneous variables that can jeopardize internal validity. More specifically, it is, at best, difficult to identify the extent to which changes in performance are related to computer assisted instruction or some other variable or group of variables. Additionally, the majority of studies looking at the influence of computer assisted instruction on reading skills have examined a variety of programs which have been only peripherally related to the traditional course content. Research has not yet taken an empirical and in-depth look at a major system of programs developed to parallel the textbooks used in the traditional classroom. This study was aimed at examining empirically the relationship between such a comprehensive program and improvement in reading skills among first and fifth graders.

CHAPTER III

METHODOLOGY

Research Design

For purposes of determining the influence of computer assisted instruction on reading skills, a nonequivalent control group design was chosen. Widely used in the field of education, this design includes an experimental group and a control group, both given a pre-test and a post-test, but the two groups do not have pre-experimental sampling equivalence. Rather, the two groups constitute naturally assembled collectives -- in this case students enrolled in grades one and five of two elementary schools.

The schema for this design can be displayed as follows where G equals group, X equals treatment, and O equals measurement on the appropriate instruments:

$$G_1 \quad O_1 \quad X \quad O_2$$

$$G_2 \quad O_3 \quad \quad O_4$$

While the addition of an unmatched or nonequivalent control group reduces greatly the equivocality of interpretation, the more similar the experimental and the control groups are in their recruitment, and the more this similarity is confirmed by the scores on the pre-test, the more effective this control becomes. When these considerations are met, this design effectively controls for the main effects of history, maturation, testing, and instrumentation, in that the difference for the experimental group between pre-test and post-test (if greater than that for the control group) cannot be explained by main effects of these variables -- since both groups would be similarly affected (Campbell and Stanley, 1963). Hence, the difference could conceivably be explained by the treatment effect -- computer assisted instruction.

Treatment

The treatment for this quasi-experiment consisted of 60 (first graders) to 90 (fifth graders) minutes per week of computer assisted instruction in reading. This computer instruction took place on a PLATO/WICAT System 300. The PLATO//WICAT System 300 is a minicomputer with hard-disk storage that supports up to 30 student work stations with graphics, animation, and high-quality audio capabilities. Each computer lesson is automatically tailored to meet the needs of the individual student. Interactive exercises encourage students to develop higher order thinking skills. They also provide drill and practice.

The computer's central processor works with each student individually, providing appropriate material, collecting data, and reporting on individual performance as students proceed through the material at their own pace. This individualistic approach with instant feedback provides teachers with up-to-the-minute student-management information that allows them to monitor student performance and progress and to identify specific areas where a student requires individual attention.

The curriculum used in this study was especially written for the PLATO/WICAT system to match the adopted classroom textbooks. Additionally, the learner outcomes written by the Oklahoma State Department of Education were incorporated in the computer curriculum, and this computerized curriculum was pilot tested for a period of six months.

The computer lab used in this study is housed at Taft Elementary School in Enid, Oklahoma. It is an air-conditioned facility which contains one manager's terminal (T-7000) and 30 terminals arranged in five rows of six terminals each. Each computer terminal is housed in a partitioned cubicle or work station to minimize students' interaction with each other and to maximize their interaction with the computer. A map of the lab facility is provided in Figure 2 (arrows signify placement of items in lab).

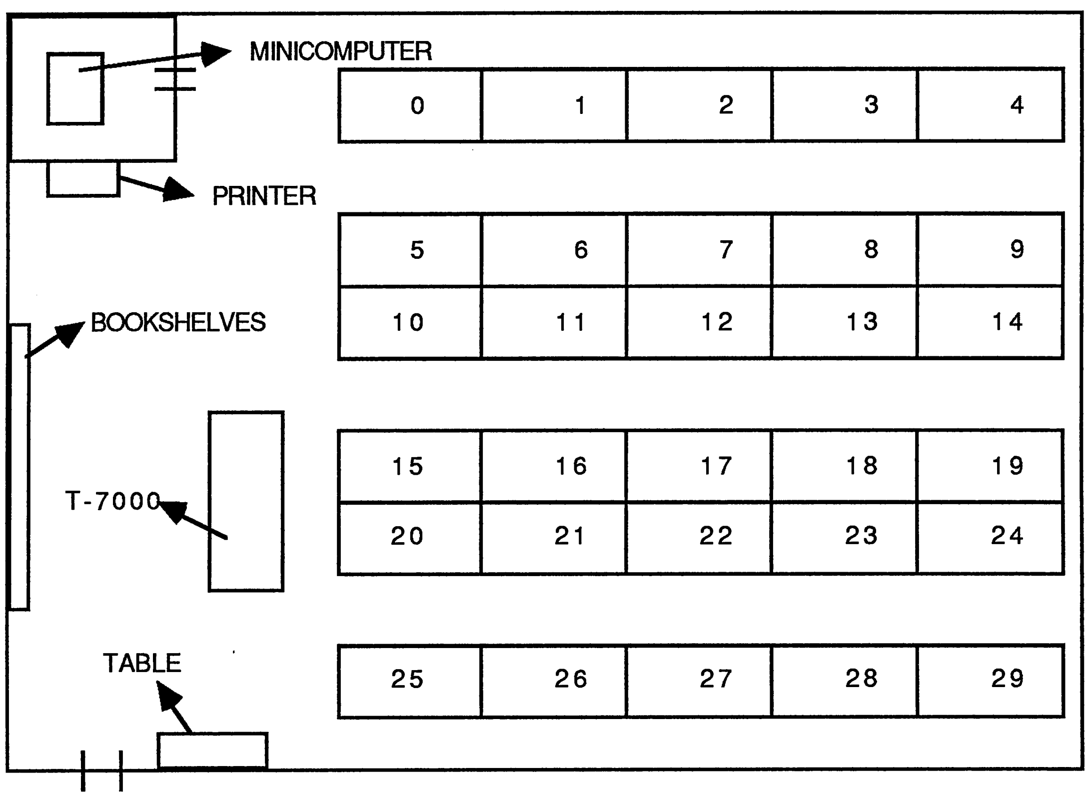

Figure 2. Diagram of Computer Lab

WICAT Primary Reading Curriculum

The WICAT Primary Reading curriculum is a computer assisted program designed to complement and enhance in-class reading skills instruction for grades one through six. The curriculum introduces decoding, contextual analysis, and meaning identification skills. It also provides for their practice and offers numerous opportunities for application.

The curriculum consists of 13 strands, or recurring types of activities, which are presented to students at regular intervals in the form of lessons as they progress through the curriculum. The strands are as follows (WICAT Primary Reading Teacher's Reference Manual, 1984):

Letter Match (letter discrimination)

Picture Stories (picture story sequencing)

Letter Find (letter identification)

Letter Sounds (initial consonant sounds, "by name" or "by sound")

Sight Words (sight word identification)

Sound Patterns (sound pattern practice I)

Sight Word Sentences (sight word practice in context)

Picture Sentences (sentence comprehension)

Reading Stories (paragraph comprehension)

More Sound Patterns (sound patterns II and review)

Word Meanings (Word identification through context)

Many Meanings (deciding among multiple meanings)

Digging for Meaning (word meanings through context)

A lesson consists of several activities from different strands interleaved with one another so that similar learning experiences are separated. This results in distributed practice, rather than the massed practice which has proven less effective.

Each activity in a lesson contains (1) a teaching sequence, in which material to be learned is introduced and (2) a practice sequence, in which the appropriate responses are repeated to mastery. The practice sequence contains not only the questions that elicit the appropriate responses, but a retesting sequence in which the original material is repeated in a different context. Mastery is determined by students' performance in successive instances. Skills are retested over a series of many lessons so that continuing mastery is assured. High-quality audio is also used for instructions, prompts, help, and feedback. The audio is also interactive and can be repeated on demand. In short, students receive instant audio as well as video feedback on both correct and incorrect responses.

Creative and meaningful uses of graphics throughout the curriculum maintain high student interest. Additionally, student progress is displayed graphically on the screen to keep students posted on how far they have come and how far they have to go.

The Primary Reading curriculum is managed jointly by the classroom teacher and the computer through the Primary Reading Manager, a program which monitors student progress, and evaluates and keeps detailed records on student performance. The manager enables teachers to control important parameters such as the level of difficulty or the allotted response time for the class as a whole or for individual students. These parameters are determined by the teacher and programmed by the lab manager, the individual who directs instructions to each student terminal. Weekly printed reports of student performance enable teachers to monitor student growth and to adjust individual learning plans as necessary.

WICAT Reading Comprehension Program

WICAT's Reading Comprehension program is a series of computer assisted instruction lessons that use language, motivation, perception, and concept development to help students in grades two through six improve their reading comprehension skills. The program teaches thirty-eight skills (displayed in Figure 3) that are presented through four protocols (WICAT Reading Comprehension (4-8) Teacher's Reference Manual, 1984).

1. **Inference** - drawing inferences from a text.
2. **Deletion** - deleting parts of a passage that do not contribute to the meaning of the whole.
3. **Graph Interpretation** - interpreting data presented in graph, chart, diagram, map or tabular form, and then relating the data to textual material.
4. **Argumentation** - judging the validity of an argument based on stated criteria and evidence, and distinguishing between statements of fact and opinion.

The management component of the program allows the teacher to:

* place the students at their own reading level within each of the four protocols
* set parameters for notification of problems
* lock the class or individuals out of particular protocols of lessons
* require the students to use passwords in order to access the curriculum
* control the frequency of keyword selection for the class or for an individual

LITERAL/TRANSLATION

1. Recognizes sentence meaning
2. Follows instructions
3. Recognizes and recalls detail
4. Selects the main idea
5. Recognizes meaning from syntactic or rhetorical relationships
6. Understand anaphoric relationships
7. Locates places and information

INTERPRETIVE

8. Categorizes data and information
9. Relates non-textual information to text
10. Recognizes relevant information
11. Identifies cause and effect relationships
12. Recognizes time order
13. Interprets meaning of words from context cue analysis
14. Compares and contrasts information

INFERENTIAL

15. Infers the main idea
16. Infers supporting detail
17. Infers relevance and significance
18. Infers character/ feelings
19. Infers mood and tone
20. Infers author's main points
21. Predicts outcomes
22. Derives consequences
23. Infers setting
24. Infers time and locale
25. Draws conclusions

APPLIED

26. Solves problems
27. Uses map, graph skill to interpret data
28. Reads to fulfill a purpose

ANALYTICAL

29. Distinguishes appropriate summaries
30. Superordinates and subordinates major and minor ideas and information
31. Identifies support for an argument
32. Monitors comprehension
33. Justifies conclusions
34. Justifies conclusions intent

SYNTHETICAL

35. Distinguishes appropriate summaries

EVALUATIVE/CRITICAL

36. Selects criteria for judging a piece of writing
37. Decides fit of text to criteria
38. Accepts or rejects argument based on criteria

Figure 3. 4-8 Reading Comprehension Taxonomic Skill

Source: WICAT Reacing Comprehension (4-8) Teacher's Reference Manual. Orem, Utah: WICAT Systems, Inc., 1984.

Additionally, the WICAT Reading Comprehension Program continuously monitors each student's achievement on such items as:

* scores
* the number of lessons the student has failed and has not reselected
* time spent in the lessons
* total number of lessons the student has mastered
* current reading level in each type of lesson

This information is then made available to the teacher through three reports: (1) class summary report, (2) individual progress report, and (3) individual trace report. From the information obtained from these reports, the teacher can direct each student's use of the curriculum.

Control

The Traditional Classroom Reading Program

The traditional classroom reading program which has been adopted by the Enid Public School is comprised of three modalities: (1) the auditory-visual reading program, (2) the visual-auditory reading program, and (3) the remedial reading program. The textbooks used for reading within the classroom have also been adopted by the Enid Public School System.

Auditory-Visual Method

The auditory-visual or "phonetic first" approach to teaching reading is appropriate for those students with strong auditory and visual discrimination skills. The learner must hear and accumulate a number of sound-symbol associations in decoding words. This transfer appears early when one is learning to read and the pace of decoding skill development is quite rapid. This process requires a great deal of auditory-visual input on the part of the student. The books selected for the first grade auditory-visual group include First Light, Rainbow Morning, Early Tide, Sea Castles, Quiet Treasures, and Sunshine Day. The book selected for the fifth grade auditory-visual group is Uncharted Waters. All books used in the auditory-visual program have been published by Economy Press (1986).

Visual-Auditory Method

The visual-auditory or "sight word with whole word phonics" approach to reading instructions requires stronger visual skills with fewer auditory strengths. The student starts with meaningful reading of whole words, sentences, and stories which are closely related to his or her own experiences and interests. The skill development program is dependent upon an accumulation of sight words from the controlled vocabulary reading material. The transfer of phonics skills is, then, gradual in application. The books selected for the first grade visual-auditory group include Away We Go, Taking Off, Going Up, On Our Own, Hang On to Your Hat, and Kick Up Your Heels. The book selected for the fifth grade visual-auditory group is Sky Climbers. All books used in the visual-auditory program have been published by Scott-Foresman (1985).

Remedial Method

The remedial group is taught using a visual-auditory method that moves at a slower pace than the second group. The books selected for the first grade remedial group include I Can Read, Work and Play, Big and Little, You and Me, Hop, Skip, and Jump, and Hide and Seek. The book selected for the fifth grade remedial group is Rough and Ready. All books used in the remedial group have been published by Scott-Foresman (1985).

Reading Groups Placement Procedure

All students in both the experimental and the control group have been placed in the multi-modality reading program. Placement into one of the three reading groups was based on each student's performance on a standardized test.

Grade One

All first grade students were administered the Metropolitan Readiness Test - Form II - Level P at the end of the Kindergarten year. This test has both an auditory-visual section and a visual-auditory section. The auditory-visual section is further divided into two subsections. These subsections include "Beginning Consonants" and "Sound/Letter Correspondence." Similarly, the visual-auditory section is divided into two subsections, "Visual Matching" and "Finding Patterns." From these four subsections, four stanine scores were computed. If a student 's two auditory-visual scores were higher than his two visual-auditory scores, he/she was placed in the auditory-visual reading group. Similarly, if a student's two visual-auditory scores were higher than his/her two auditory-visual scores, he/she was placed in the visual-auditory group. If a student's auditory-visual scores and visual-auditory scores were about the same, the teacher is asked to make a placement recommendation based on careful observation of the student and the student's past performance. If a student's total stanine score (sum of the four subsections) was 3 or below, he/she was placed in the remedial reading group.

Grade Five

While fifth grade students were placed in a reading group from first grade, these placements are reviewed each year on the basis of the Gates MacGinitie Reading Test Level D and teacher recommendation. Using the total Stanine score (ranging between 9 and 1) a student with a score lower than 4 was placed in the remedial group. A student with a score between 9 and 6 may be placed in the auditory-visual group. Likewise, a student with a score between 7 and 4 may be placed in the visual-auditory group. Since placement scores for the auditory-visual and visual-auditory groups overlap, a student whose total stanine score fell in the overlap area was placed based upon teacher recommendation. When asked for recommendations, teachers were reminded to consider a student's total stanine score, past placement, and past performance.

Subjects

The subjects for this study were 85 first graders and 78 fifth graders enrolled in two elementary schools in Enid, Oklahoma. Approximately half (47%) of these students were enrolled in a school using the WICAT System 300 while the remainder (53%) were enrolled in a school with no computer facilities. Six students from the school with computer facilities (i.e. 3 with no pre-score and 3 with no post-score) and seven students from the school with no computer facilities (i.e. 4 with no pre-score and 3 with no post-score) were eliminated from this study. These students either moved to one of these schools after the pre-test was administered or moved to another school before the post-test was administered.

Selection of the control group was based on several criteria including (1) school size and (2) socioeconomic status of the schools as determined by the percentage of students enrolled in the free lunch program. At the beginning of the 1986-87 school year, enrollments at Taft numbered 335 while at McKinley enrollments numbered 331. At the beginning of the school year, 26.6 percent of Taft students were enrolled in the free lunch program. At McKinley 28.4 percent of the students were enrolled in the free lunch program. Over the course of the school year, these percentages varied no more than one percent in either direction.

Description of the Control Group

Grade One

There were two first grade classes in the control group. Class A had 9 students in the auditory-visual group, 9 students in the visual-auditory group, and 4 students in the remedial group. Class B had 8 students in the auditory-visual group, 11 students in the visual-auditory group, and 4 students in the remedial group. Both classes A and B spent approximately 45 minutes per day per group on reading activities. Additionally, the teachers for both classes taught their reading groups in the same order: remedial group, visual-auditory group, and auditory-visual group.

All reading groups convened at the reading table. Before calling the first reading group, both first grade teachers made assignments with detailed instructions to both the visual-auditory and the auditory-visual groups. Generally speaking, assignments involved a review of those materials the reading group had dealt with the previous day. These assignments included either independent worksheets or pages to be completed in the student workbook.

The procedure that both first grade teachers followed for all reading lessons adhered to the suggestions made in the teachers' manual. All three reading groups (auditory-visual, visual-auditory, and remedial) made use of flashcards, skill charts, workbooks, reading dittos, teacher-made materials, supplementary reading books, games, and pre and post reading tests given on each reading book.

Grade Five

There were two fifth grade classes in the control group. Class A had 8 students in the auditory-visual group and 12 students in the visual-auditory group. Class B had 10 students in the auditory-visual group and 11 students in the visual-auditory group. Neither class had any students in a remedial group. Both classes A and B spent approximately 45 minutes per day per group on reading activities. The teacher of class A worked first with the auditory-visual group and second with the visual-auditory group although she did indicate the order sometimes varied as a function of the reading assignments. The teacher of class B worked first with the visual-auditory group and second with the auditory-visual group, and she also indicated the order did sometimes vary as a function of the reading assignments

All reading groups convened at the reading table. Both teachers put the reading assignments on the chalkboard at the beginning of each day. Instructions for these assignments were given to the entire class before the first reading group convened. Students were instructed to work independently on these assignments while the opposite reading group was meeting.

The procedure both fifth grade teachers followed adhered to the suggestions provided in the teachers manual. The types of materials used were the same for both classes and included skill charts, workbooks, reading dittos (vocabulary and comprehension), chalkboard, overhead projector, tape recorder, supplementary reading books, and pre and post reading tests given on the reading book.

Description of the Experimental Group

Grade One

There were two first grade classes in the experimental group. Class A had 8 students in the auditory-visual group, 6 students in the visual-auditory group, and 4 students in the remedial group. Class B had 10 students in the auditory-visual group, 8 students in the visual-auditory group, and 4 students in the remedial group. On those days when computer time was not planned, both classes spent approximately 45 minutes per group in reading activities. On those days when students were scheduled for 20 minutes of computer time (reading activities), the classroom reading group sessions were reduced to 25 minutes. Both first grade teachers worked with the remedial group first. Additionally, both teachers worked with the visual-auditory group second and the auditory-visual group third.

All reading groups convened for reading at the reading table. The teacher for class A had her students complete a penmanship assignment and a review reading sheet while she worked with the other two groups. The teacher of class B had her students complete a review ditto and then a "fun or color" sheet while she worked with the other two reading groups. Students in both first grade classes were allowed to read a library book if they finished their assignments before their reading group was called. Additionally, as the school year progressed and students' reading skills improved, all were encouraged to read the daily assignment at their desks before their reading group was called.

The procedures both first grade teachers followed for each reading lesson adhered to the suggestions made in the teachers manuals. All three reading groups made use of flashcards, skill charts, workbooks, reading dittos, teacher-made materials, supplementary reading books, games, and pre and post tests on each reading book. Additionally, each student had three 20 minute reading sessions on the computer each week. Over the course of the school year, first graders logged an average of 21 hours on the computer with an average of 25 lessons completed.

Grade Five

There were two fifth grade classes in the experimental group. Class A had 8 students in the auditory-visual group and 10 students in the visual-auditory group. Class B had 9 students in the auditory-visual group and 10 students in the visual-auditory group. Neither fifth grade class had any students in a remedial group. On those days when computer time was not planned, both classes A and B spent approximately 45 minutes per group on reading activities. On those days when students were scheduled for 30 minutes of computer time (on reading activities), the classroom reading group sessions were reduced to 15 minutes. The teacher of class A met first with the visual-auditory group and second with the auditory-visual group although she noted that exceptions were sometimes made. The teacher of class B alternated the reading groups each day, and also noted exceptions to this rule were sometimes made.

All reading groups convened at the reading table. Before calling the first reading group, both teachers put an assignment on the chalkboard for the other reading group. Verbal instructions were also given. Students worked on this assignment while not in a reading group. Students completing an assignment early were permitted to get a library pass.

The procedure both fifth grade teachers followed for all reading lessons adhered to the suggestions made in the teachers manuals. Materials used included skill charts, workbooks, reading dittos (vocabulary and reading comprehension), chalkboard, record player, tape recorder, supplementary readers, and pre and post reading tests given on the reading book. Additionally, each student spent three 30 minute reading sessions per week on the computer. Over the course of the school year, fifth graders logged an average of 25.5 hours on the computer with an average of 88 lessons completed.

Instrumentation

<u>Comprehensive Test of Basic Skills (CTBS) Form U</u>

The instrument used to measure reading skills was the Comprehensive Test of Basic Skills (CTBS) Form U Level B (Grade One) and Level G (Grade Five). In CTBS Form U, the process of reading is defined in terms of visual discrimination, decoding and recognition of words, recall of word meaning, and three levels of comprehension -- finding specific information, using inferential reasoning to gain information, and evaluating information to make a judgment.

The scale score is the basic score for CTBS Form U. It is used primarily to provide a basis for deriving various other normative scores to describe test performance. Scale scores, expressed in numbers that can range from 0 through 999, are produced from a single, equal-interval scale of scores across all grades for use with all levels and forms of CTBS U and V. There are two ways to obtain scale scores for the individual tests. The first method, referred to as IRT scoring, is based on Item Response Theory. This method uses a computer to calculate scale scores by applying computational procedures directly to the item responses. The obtained scale scores are based on the overall pattern of correct and incorrect responses, rather than simply on the number of correct responses. Using this method, it is possible for students with the same number of correct responses to receive different scores. The second method, number correct scoring, requires converting the number of correct responses to a scale score by using a conversion table. The CTBS manual compares the two scoring methods with the following example:

> Two students answer the same number of items correctly. The responses of one student show a consistent pattern -- the easier items are answered correctly, but items beyond a certain level of difficulty are missed. The other student's responses show an inconsistent pattern -- the correct responses are scattered across all levels of difficulty; some of the easier items are missed and some of the more difficult ones are answered correctly. It would seem likely that the latter student's pattern of responses reflects a certain amount of guessing. Using number-correct scoring, both students would receive the same score. By considering each item's characteristics -- its discrimination, location parameter, and "guessability" -- IRT scoring can differentiate between such students and will yield a higher estimate of ability for the former student. In effect, IRT scoring takes into account the fact that not all correct answers in a test are equally good indicators of a student's level of achievement. (31-32).

The IRT method provides a somewhat more accurate estimate of a student's true performance level than the number-correct method; however, the latter is sometimes preferred because of its familiarity and conceptual simplicity. This study has used the IRT method of scoring because of its greater accuracy.

The validity of greatest concern to the classroom teacher is content validity. To ensure content validity of the materials, several methods were applied to verify their accuracy, currency, and curricular relevance. First, current curriculum guides were obtained from state departments of education and from major cities and large school districts throughout the country. The content of recently published textbook series and instructional programs was also examined. The basic skills identified as common to most curricula were then compared to the objectives of recently published CTB/McGraw-Hill products, including the California Achievement Tests, Forms C and D (CAT C and D), the Prescriptive Reading Inventory/Reading Systems (PRI/RS), and the Diagnostic Mathematics Inventory (DMI). From this compilation of educational objectives, the content for CTBS U and V was defined. Second, to provide a large pool of items for final test selection, two to three times as many items as would be needed were developed. A staff of professional items writers, most of them experienced teachers, researched and wrote items and passages to be tried out. All items and test directions were carefully reviewed for content and editorial accuracy. Third, items were tried out in schools throughout the country. The teachers who administered the item tryout books (test booklets) were asked to review the content, illustrations, instructions, and time limits and to provide comments. Many improvements in CTBS U and V reflect the comments and suggestions of these teachers. Fourth, vocabulary difficulty was controlled by reference to EDL Core Vocabularies in Reading, Mathematics, Science, and Social Studies and The Living Word Vocabulary.

Instrument reliability was established with the Kuder-Richardson Formula 20. Use of this statistical procedure demonstrates that this instrument has good reliability. Specifically, on a single administration of a test, this formula provided a realiability estimate that equals the average of all split-half coefficients that would be obtained on all possible divisions of the test into halves (Comprehensive Test of Basic Skills, 1982).

Test of Cognitive Skills (TCS)

Intelligent Quotient was measured for fifth graders only with the Test of Cognitive Skills. The Test of Cognitive Skills (TCS) is a series of ability tests designed to assess the level of aptitude attained by students. Some abilities cannot be measured directly, but must be inferred by assessing behaviors that reflect those abilities. The level of test performance depends on the abilities students have developed through experiences. The diverse backgrounds of language and cultural opportunities of the students are also taken into account. The test is not intended to measure all aspects of mental ability, nor does it include only those aptitudes and skills that are functions of formal school training. Emphasis is placed on abilities of a relatively abstract nature that are important to success in an educational program. Such functions include understanding verbal and nonverbal concepts and comprehending relationships among ideas presented in a variety of forms.

TCS is a major revision of, and the successor to, the Short Form Test of Academic Aptitude (SFTAA). TCS has the same basic structure as SFTAA. There are four subtests at each of the five levels. The structure and rationale for two of these four subtests, Sequences and Analogies, remains the same as in SFTAA. However, the SFTAA vocabulary test has been replaced with a test of

Verbal Reasoning. The TCS Memory test is also a new test, designed to provide a measure of memory that is not dependent on reasoning or reading comprehension skills.

The scale score is the basic score for TCS. There are two ways to obtain scale scores for TCS subtests. The first method is based on Item Response Theory. By means of a computer, subtest scale scores are calculated by applying an iterative alogrithm directly to the item responses. This method is normally used when CTB/McGraw-Hill scores the tests. The second method, which is simpler but somewhat less accurate, is to convert the number of correct responses (number-correct score) in a given subtest to a scale score by using a conversion table. Conversion tables are published in each TCS Norms Book. This study has used the IRT method of scoring because of its greater accuracy.

Scale scores are units of a single, equal-interval scale applied across all levels of TCS regardless of grade or time of year of testing. These scores are expressed in numbers that range from 0-999. The equal-interval property of the scale makes scale scores especially appropriate for various statistical purposes.

To provide a large pool of items for final test selection, more than twice the number of items needed were developed by a staff of professional item writers, most of whom were experienced teachers. The item selection process for TCS involved the application of Item Response Theory (IRT) and the implementation of a three-parameter statistical model that takes into account item discrimination, difficulty, and guessing. For each item, discrimination and difficulty indices were considered, as well as the model-fit index and bias rating. Those items with the best overall statistical quality that also met the established content criteria were chosen for the Standardization Edition.

During the development of TCS, careful attention was given to ethnic, age, handicap, and gender bias. All tryout items were examined for empirical evidence of bias. For each test level, separate item data were gathered for black and Hispanic students. Data for these groups were compared, and items that appeared to be biased were either eliminated or revised (Test of Cognitive Skills, 1981).

Procedure

Within the first five weeks of the fall semester of 1986, all first graders in the two targeted schools were administered the CTBS Form U Level B. Additionally, all fifth graders in the two targeted schools were administered the CTBS Form U Level G and the TCS Level 3. For the remainder of the school year, students in the control groups were taught reading using the traditional classroom method. Students in the experimental groups were taught reading using the the traditional classroom method as well as the computer assisted reading program of the PLATO/WICAT System 300. All first grade students in the experimental groups were placed in the WICAT Primary Reading Program and remained there for the entire school year. All fifth grade students in the experimental groups were initially placed in the WICAT Primary Reading Program, and were required to master this program with a score of 80 percent or better in order to advance to the WICAT Reading Comprehension Program. First grade students in the experimental group spent twenty minutes per session three days per week on computer reading activities. Fifth grade students in the experimental group spent thirty minutes per session three days per week on computer reading activities. These computer reading activities were continuously monitored by the teachers in order to maximize the learning experience for the students. Approximately five weeks before the end of the spring semester, all first graders in both groups were tested again using the CTBS Form U Level B, and all fifth graders in both groups were tested again using the CTBS Form U Level G and the TCS Level 3.

Additionally, throughout the school year, this researcher made regular and frequent visits to the computer lab to observe students' interactions with the computer. More specifically, this researcher visited the computer lab two or three times a week and made mental notes of students' and teachers' responses, both positive and negative. These notes were immediately recorded in a notebook upon returning to the office.

Time was also spent talking informally to students during periods when they were not involved in formal study. Information was also gleaned from teachers through informal interviews and conversations. These data were used to gain a sense of teachers' and students' attitudes toward the computer lab.

It should be noted that this researcher is the principal in the experimental school and hence is the immediate supervisor to all participating teachers in this environment. It should also be noted that although this researcher was not responsible for the decision to place this computer lab in the school, she was pleased with the decision, and hence, might be viewed as somewhat biased in favor of computer assisted instruction.

CHAPTER IV

RESULTS

The purpose of this chapter is to present the results of the analysis of data collected from 163 first and fifth graders serving as the control and experimental groups in this study. The two main hypotheses were tested with the analysis of covariance procedure using change in reading skills over the school year (post-score - pre-score) as the dependent variable. The independent factor in the covariance model was group (i.e. experimental/control). The covariate in the model was reading score at the beginning of the school year (i.e. pre-score). Additionally, in the analysis of the fifth grade sample, I.Q. was introduced as a covariate. All hypotheses were tested using the .05 level of significance. All statistics were computed using the Statistical Package for the Social Sciences/Personal Computer Plus (SPSSPC+).

Equivocality of Groups

First Graders

To establish the equivocality of groups with respect to reading skills for first graders at the beginning of the school year, the average reading scores (i.e. pre-score) for the two first grade groups (i.e. experimental/control) were compared using the t test for independent samples. The average pre-score for the first grade experimental group was 417.64. The average pre-score for the first grade control group was 442.60. Independent t test analysis indicates these two averages were not significantly different ($t = 1.55$; $p > .05$), suggesting the two first grade groups are equal with respect to reading skills at the beginning of the school year. Average pre-scores for the first grade experimental and control groups are displayed in Table I.

To further establish the equivocality of groups with respect to reading skills for first graders at the beginning of the school year, average reading scores for the two first grade groups (experimental/ control) were compared holding sex constant. That is, the average pre-score for males in the experimental group was compared to the average pre-score for males in the control group. Similarly, the average pre-score for females in the experimental group was compared to the average pre-score for females in the control group. Independent t test analysis indicates the average pre-score for males in the experimental group is significantly different from the average pre-score for males in the control group with males in the control group displaying the significantly higher average ($t = -3.06$; $p < .004$). The average pre-score for males in the experimental group was 385.43 while the average pre-score for males in the control group was 443.35. In contrast, independent t test analysis indicates the average pre-score for females in the experimental group was not significantly different from the average pre-score for females in the control group ($t = .16$; $p > .05$). The average pre-score for females in the experimental group is 445.83 while the average pre-score for females in the control group is 441.85. Average pre-scores by sex for the first grade experimental and control groups are displayed in Table I.

The significant difference between the average pre-scores for males in the experimental and control groups clearly supported the importance of controlling for sex and pre-score in any further analysis of first graders.

Inclusion of these variables in further analysis was necessary to hold constant (i.e. remove the effects of) both sex and pre-score and thereby establish the equivocality of groups with respect to these variables.

TABLE I

MEAN PRE-, POST-, AND CHANGE-SCORES FOR THE FIRST GRADE EXPERIMENTAL AND CONTROL GROUPS

	Pre-Score	Post-Score	Change
Experimental Group (n=40)	417.64	514.16	96.51
Males (n=20)	385.43	502.86	117.43
Females (n=20)	445.83	524.04	78.26
Control Group (n=45)	442.60	496.80	54.20
Males (n=21)	443.35	501.05	57.70
Females (n=24)	441.85	492.55	50.70

First grade subjects used in this study included a good mix of males and females. Within the first grade experimental group, 50 percent of the students were male and 50 percent were female. Within the first grade control group, 47 percent of the students were male while 53 percent were female. This even distribution by sex suggests equivocality of groups with respect to sex ratio.

Fifth Graders

To establish the equivocality of reading skills for fifth graders at the beginning of the school year, the average reading scores (i.e. pre-score) for the two fifth grade groups (i.e. experimental/control) were compared using the t test for independent samples. The average pre-score for the fifth grade experimental group is 709.97. The average pre-score for the fifth grade control group is 726.98. Independent t test analysis indicates these two averages are not significantly different ($t = -1.45$; $p > .05$), suggesting the two fifth grade groups are equal with respect to reading skills at the beginning of the school year. Mean pre-scores for the fifth grade experimental and control groups are displayed in Table II.

To further establish the equivocality of reading skills for fifth graders at the beginning of the school year, average pre-scores for the two fifth grade groups were compared holding sex constant. That is, males in the experimental group were compared to males in the control group. Similarly, females in the experimental group were compared to females in the control group. Independent t test analysis indicates the average pre-score for males in the experimental group is not significantly different from the average pre-score for males in the control group ($t = -94$; $p > .05$). The average pre-score for males in the experimental group was 709.72 while the average pre-score for males in the control group was 725.42. Similarly, the average pre-score for females in the experimental group was not significantly different from the average pre-score for females in the control group ($t = -1.14$; $p > .05$). The average pre-score for females in the experimental group was 710.21 while the average pre-score for females in the control group was 729.67. Mean pre-scores by sex for the fifth grade experimental and control groups are displayed in Table II.

TABLE II

MEAN PRE-, POST-, AND CHANGE-SCORES FOR THE FIFTH GRADE EXPERIMENTAL AND CONTROL GROUPS

	Pre-Score	Post-Score	Change
Experimental Group (n=37)	709.97	758.62	48.65
Males (n=18)	709.72	760.17	50.44
Females (n=19)	710.21	757.16	46.95
Control Group (n=41)	726.98	744.39	17.42
Males (n=26)	725.42	734.15	8.73
Females (n=15)	729.67	762.13	32.47

The finding of no significant difference between the average pre-scores for the experimental and control groups by sex was supportive of the assumption of equivocality of groups with respect to these two variables (i.e. sex and pre-score). Inclusion of these controls in further analysis, though, will serve to remove any effects of sex and pre-score, and thereby, ensure the continued equivocality of groups with respect to these variables.

In addition to the comparisons of initial reading scores, the average I.Q.s for the two fifth grade groups were statistically compared. At the beginning of the school year the average I.Q. for the fifth grade experimental group was 105.14. At the beginning of the year, the average I.Q. for the fifth grade control group was 106.98. Independent t test analysis indicates these two means were not significantly different ($t = -69; p > .05$), suggesting these two groups were initially equal with respect to I.Q. Likewise, at the end of the school year, the two groups did not differ significantly on average I.Q. ($t = -1.44; p > .05$). At the end of the year, the average I.Q. for the experimental group was 109.65 while the average I.Q. for the control group was 114.02. Average I.Q.s for the experimental and control groups are displayed in Table III.

Average I.Q. at the beginning and end of the school year was also compared for the experimental and control groups holding sex constant. That is, the average I.Q. for males in the experimental group was compared the the average I.Q. for males in the control group. Similarly, the average I.Q. for females in the experimental group was compared to the average I.Q. for females in the control group. Independent t test analysis indicates the average I.Q. at the beginning of the school year for males in the experimental group is not significantly different from the average I.Q. for males in the control group ($t = .71; p > .05$). The average I.Q. at the beginning of the year for males in the experimental group was 107.33 while the average I.Q. at the beginning of the year for males in the control group was 104.69. In contrast, independent t test analysis indicates the average I.Q. at the beginning of the school year for females in the experimental group is significantly different from that for females in the control group with females in the control group displaying the significantly higher average. The average I.Q. at the beginning of the year for females in the experimental group was 103.05 while the average I.Q. at the beginning of the year for females in the control group was 110.93. Mean I.Q.s at the beginning of the school year by sex for both the experimental and control groups are displayed in Table III.

A comparison of average I.Q. at the end of the school year for males demonstrated no significant difference ($t = -.32$; $p > .05$). At the end of the school year, the average I.Q. for males in the experimental group was 110.33. At the end of the school year, the average I.Q. for males in the control group was 111.54. Congruously, a comparison of average I.Q. at the end of the school year for females demonstrates no significant difference ($t = -1.87$; $p > .05$). At the end of the school year, the average I.Q. for the females in the experimental group was 109.00 while the average I.Q. for females in the control group was 118.33. The average I.Q.s at the end of the school year by sex for the experimental and control groups are displayed in Table III.

The significant difference in average I.Q. at the beginning of the school year for females in the experimental and control groups clearly established the importance of including these variables as controls in any further analysis. Inclusion of sex and I.Q. (Fall, 1986) is necessary in order to hold constant (i.e. remove the effects of) both sex and I.Q. (Fall, 1986) and thereby establish the equivocality of groups with respect to these variables.

Fifth grade subjects used in this study included a good mix of males and females. Within the fifth grade experimental group, 49 percent of the students were male while 51 percent of the students were female. Within the fifth grade control group, 63 percent of the students were male while 37 percent of the students were female. This approximately even distribution by sex suggests equivocality of groups with respect to sex ratio.

TABLE III

MEAN I.Q. FOR THE FIFTH GRADE EXPERIMENTAL AND CONTROL GROUPS IN THE FALL OF 1986 AND SPRING OF 1987

	I.Q. - Fall, 1986	I.Q. - Spring, 1987
Experimental Group (n=37)	105.14	109.65
Males (n=18)	107.33	110.33
Females (n=19)	103.05	109.00
Control Group (n=41)	106.98	114.02
Males (n=26)	104.69	111.54
Females (n=15)	110.93	118.33

Summary

A comparison of male and female first graders in the experimental and control groups on initial reading skills demonstrates that males in the experimental group are significantly different from males in the control group. Specifically, males in the control group have a significantly higher mean pre-score than males in the experimental group. Additionally, a comparison of male and female fifth graders in the experimental and control groups on average I.Q. at the beginning of the school year demonstrates that the control group of females, when compared to the experimental group of females, has a significantly higher average I.Q. The significant difference in average pre-scores for the first grade male groups points to the need to control for pre-score and sex in any further analysis of first graders. Similarly, the significant difference in average I.Q.s for fifth grade females points to the need to control for sex and I.Q. in any further analysis of fifth graders. These controls are essential to ensure the equivocality of groups with respect to these variables.

Hypothesis 1

Hypothesis 1 states the use of computer assisted instruction is significantly related to first graders' development of reading skills as measured by the Comprehensive Test of Basic Skills Form U Level B. The tested null of this hypothesis stated the use of computer assisted instruction is not significantly related to first graders' development of reading skills as measured by the Comprehensive Test of Basic Skills Form U Level B. Initial evaluation of this hypothesis was accomplished with the t test for independent samples using group (experimental/control) as the independent variable and change-score (post-score-pre-score) as the dependent variable. The average change-score for the first grade experimental group was 96.5 while the average change-score for the first grade control group was 54.2. Independent t test analysis indicated there was a significant difference between these average change-scores with the experimental group displaying the significantly higher average ($t = 2.94$; $p < .004$). The mean change-scores for both the experimental and control first grade groups are displayed in Table I. Additionally, the change data for both groups are graphically displayed in Figure 4.

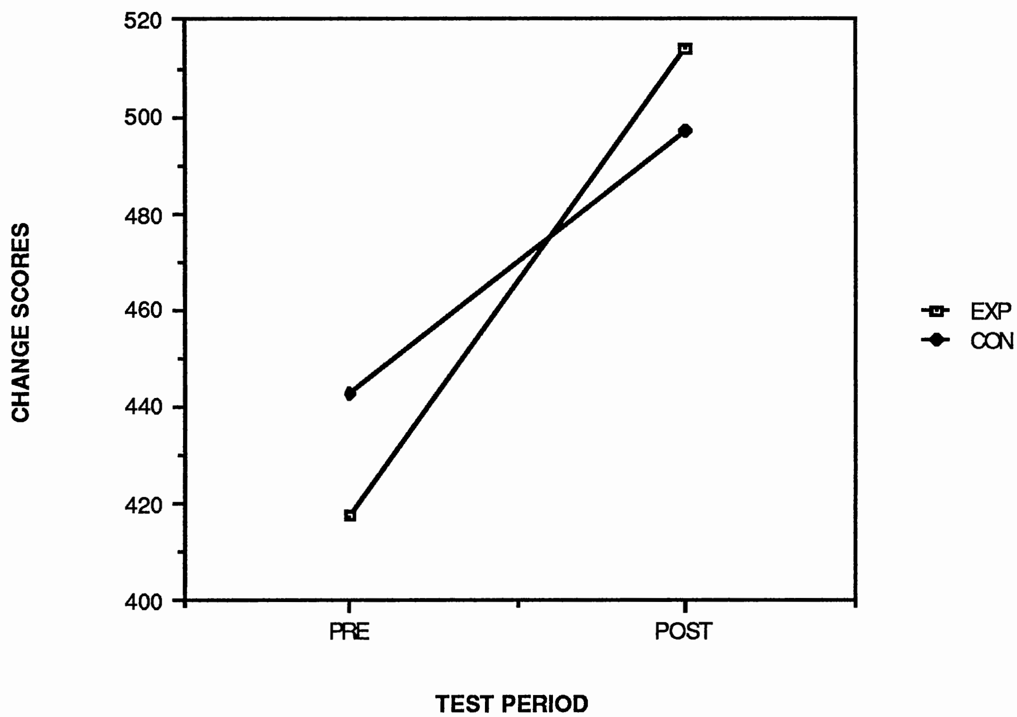

Figure 4. Plot of Pre- and Post-Scores for First Graders in the Experimental and Control Groups

Interestingly enough, when the pre- and post-scores for each group (i.e. experimental/control) were compared separately using the t test for paired samples, both groups experience significant change (experimental group: $t = 9.43$; $p < .001$/control group: $t = 5.40$; $p < .001$). However, when these average change-scores were statistically compared to each other, the evidence pointed to the conclusion that the first grade experimental group changed significantly more than the first grade control group.

To ensure the significant change observed through the use of the independent t test was not a function of unequal groups at the beginning of the school year, additional analysis was performed. First, given the significant relationship between pre-score and change-score for first graders ($r=-.64$; $p<.001$), a second test of the hypothesis was run holding pre-score constant. Specifically an analysis of covariance was run comparing the average change-scores for the two groups while controlling for pre-score. These data are displayed in Table IV.

Results of this covariance model indicate there were two significant effects. The main effect for group is significant indicating a treatment effect. The significant treatment effect results from the fact that the experimental group has a significantly higher change-score than the control group -- even with pre-score controlled. Additionally, the covariate, pre-score, was significant, indicating a relationship between pre-score and change. Since the raw regression coefficient for pre-score was negative (-600), the relation between pre-score and change was inverse. This significant inverse relationship suggested that lower pre-scores were associated with higher change-scores. Likewise, higher pre-scores were associated with lower change-scores. These two independent variables (group and pre-score) accounted for 46 percent of the variance in change-scores for the first grade experimental and control groups.

As a further test of Hypothesis 1, the average change-scores for the experimental and control groups were assessed holding sex constant. Specifically, the average change-score for males in the experimental group was compared to the average change-score for males in the control group. Similarly, the average change-score for females in the experimental group was compared to the average change-score for females in the control group. The change data for males are graphically displayed in Figure 5 while the change data for females are graphically displayed in Figure 6.

TABLE IV

COVARIANCE MODEL COMPARING AVERAGE CHANGE-SCORES FOR THE FIRST GRADE EXPERIMENTAL AND CONTROL GROUPS WHILE CONTROLLING FOR PRE-SCORE

Source	SS	df	MS	F	Sign
Covariate					
Pre-Score	167633.50	1	167633.50	62.9	.000
Main Effects					
Group	16296.25	1	16296.25	6.12	.015
Explained	183929.74	2	91964.87	34.51	.000
Residual	218522.66	82	2664.91		
Total	402452.40	84	4791.10		

Additionally, given the significant difference in average pre-scores for males in the experimental and control groups, a fourth test of hypothesis 1 was made to determine if pre-score and sex differences were distorting statistical results. Specifically, two additional analysis of covariance models were run: the first included males only and the second included females only. In each of these covariance models the average change-scores for the two groups (experimental/control) were compared while controlling for pre-score. The data for males are displayed in Table V while the data for females are displayed in Table VI.

Males

Independent t test analysis indicate that the average change-score for males in the experimental group was significantly different from the average change-score for males in the control group with males in the experimental group displaying the significantly higher average ($t = 2.87$; $p < .007$). The average change-score for males in the experimental group is 117.43 while the average change-score for males in the control group was 57.70. (See Figure 5.)

In contrast, results of the covariance model for males indicate there was only one significant effect . The covariate, pre-score, was significant, indicating a relationship between pre-score and change. Since the raw regression coefficient for pre-score is negative (-.671), the relation between pre-score and change was inverse. This significant inverse relationship suggested that lower pre-scores were associated with higher change-scores. Likewise, higher pre-scores were associated with lower change-scores. This two independent variable model (group and pre-score) explained 41 percent of the variance in change-scores for first grade males. Since the zero order correlation between change and pre-score for first grade males was -.62, it was apparent that virtually all of the explained variance (i.e. 38%) in change was identified with pre-score -- with group (experimental/control) explaining little, if any, variance in change.

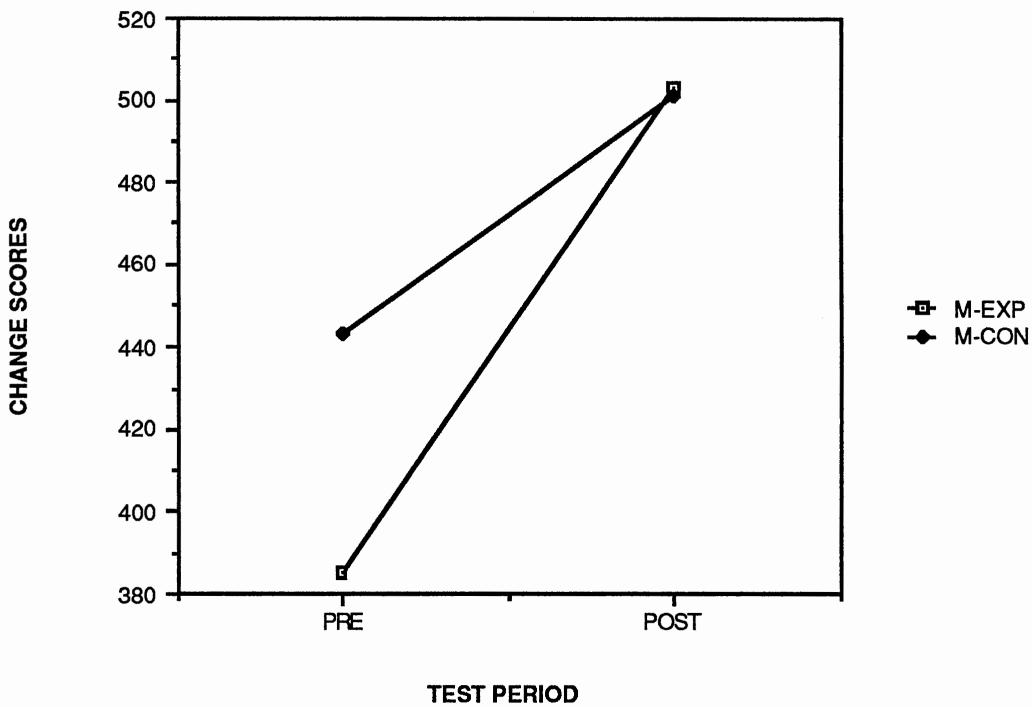

Figure 5. Plot of Pre- and Post-Scores for First Grade Males in the Experimental and Control Groups

As already noted, the main effect for treatment was not significant indicating there is no treatment effect among first grade males. In short, the significant difference between groups (i.e. treatment effect) which was observed through the independent t test analysis disappears once pre-score is controlled.

This finding suggested that failure to control for pre-score effects among males distorts statistical findings. (See Table V.)

TABLE V

COVARIANCE MODEL COMPARING AVERAGE CHANGE SCORES FOR FIRST GRADE MALES IN THE EXPERIMENTAL AND CONTROL GROUPS WHILE CONTROLLING FOR PRE-SCORE

Source	SS	df	MS	F	Sign
Covariate					
Pre-Score	79930.29	1	79930.29	24.45	.000
Main Effects					
Group	5529.81	1	5529.81	1.69	.201
Explained	85460.10	2	42730.05	13.07	.000
Residual	124254.39	38	3269.85		
Total	209714.49	40	5242.86		

In sum, the findings of this model suggest that improvement in reading skills (i.e. change) among first grade males was significantly related to initial reading skills but not to the treatment -- the inclusion or exclusion of computer assisted instruction in the learning process. In short, failure to find a significant treatment effect suggested improvement in reading skills (i.e. change) will occur among first grade males independent of computer assisted instruction.

Females

Independent t test analysis indicated the average change-score for females in the experimental group was not significantly different from the average change-score for females in the control group ($t = 1.41$; $p > .05$). The average change-score for females in the experimental group was 78.21 while the average change-score for females in the control group was 50.70. (See Figure 6.)

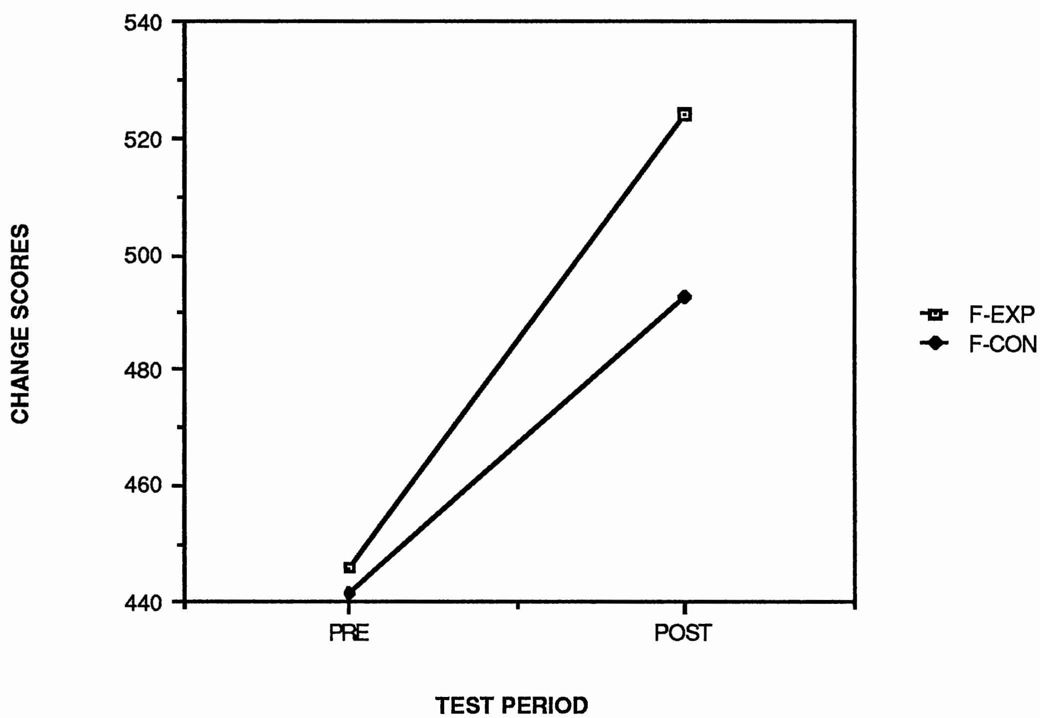

Figure 6. Plot of Pre- and Post-Scores for First Grade Females in the Experimental and Control Groups

In contrast, results of the analysis of covariance model for females indicate there were two significant effects. The main effect for group is significant indicating a treatment effect. The significant treatment effect resulted from the fact that the experimental group had a significantly higher change-score than the control group when pre-score was controlled. Additionally, the covariate, pre-score, was significant, demonstrating a significant relationship between pre-score and change-score. Since the raw regression coefficient for pre-score was negative (-.542), the relation between pre-score and change was inverse. This significant inverse relationship suggested that lower pre-scores were associated with higher change-scores. Likewise, higher pre-scores were associated with lower change-scores. (See Table VI.)

TABLE VI

COVARIANCE MODEL COMPARING AVERAGE CHANGE SCORES FOR FIRST GRADE FEMALES IN THE EXPERIMENTAL AND CONTROL GROUPS WHILE CONTROLLING FOR PRE-SCORE

Source	SS	df	MS	F	Sign
Covariate					
Pre-Score	79077.69	1	79077.69	34.78	.000
Main Effects					
Group	9608.16	1	9608.16	4.23	.046
Explained	88685.84	2	44342.92	19.50	.000
Residual	93223.32	41	2273.74		
Total	181909.16	43	4230.45		

This two independent variable model (group and pre-score) explained 49 percent of the variance in change-scores for first grade females. Given a zero order correlation between change and pre-score for first grade females of .65, it was apparent that pre-score is explaining approximately 42 percent of the variance in change-scores for first grade females. The remaining seven percent (49%=42%+7%) was identified with the treatment effect -- inclusion or exclusion of computer assisted instruction in the learning process.

As already noted, the main effect for treatment was significant indicating there was a treatment effect among first grade females. In short, the finding of no significant difference between groups (i. e. no treatment effect) which was observed through the independent t test analysis is reversed when pre-score is controlled. This finding would suggest that failure to control for pre-score effects among females distorts statistical findings.

In sum, the significant treatment effect, coupled with the significant pre-score effect, would suggest that improvement in reading skills (i.e. change) among first grade females is related to both initial reading skills and treatment -- inclusion or exclusion of computer assisted instruction in the learning experience. More specifically, lower pre-scores are associated with higher change-scores. Likewise, higher pre-scores are associated with higher change-scores. Additionally, those females whose traditional classroom reading activities are augmented with computer assisted instruction will experience greater change than those females who traditional reading activities are not so augmented.

Summary of Findings for Hypothesis 1

Results of the first covariance model which included males and females demonstrated both a treatment effect and a pre-score effect. This first model would suggest there is a significant difference between the average change-scores for the first grade experimental and control groups (males and females included) with the experimental group demonstrating a significantly higher change-score than the control group. Additionally, this model would suggest that variance in change-scores is related to initial reading skill as well as treatment (computer assisted instruction/no computer assisted instruction). Acceptance of this model would dictate rejection of the null hypothesis for both males and females.

However, an initial pre-score difference with respect to first grade males would suggest a more appropriate model for analysis is one which examines males and females separately. Independent t test analysis indicated that the average change-score for first grade males in the experimental group was significantly different from the average change-score for first grade males in the control group. In contrast, independent t test analysis indicated that the average change-scores for first grade females in the control and experimental groups were not significantly different. However, the findings of both independent t tests were reversed when pre-score was controlled. More specifically, results of the covariance model for males demonstrated only a pre-score effect. This model revealed no treatment effect for first grade males. In contrast, the covariance model for females demonstrated both a pre-score effect and a treatment effect.

In short, the significant treatment effect (experimental/control) observed in the covariance model which included both males and females appears to be a function of the significant treatment effect observed among females. The findings of the covariance models with sex held constant suggest that the null hypothesis must be rejected for females but not for males. Restated, the use of computer assisted instruction is significantly related to first grade female's development of reading skills as measured by the Comprehensive Test of Basic Skills Form U Level B. Use of computer assisted instruction is not significantly related to first grade male's development of reading skills as measured by the Comprehensive Test of Basic Skills Form U Level B.

Hypothesis 2

Hypothesis 2 states the use of computer assisted instruction is significantly related to fifth graders' development of reading skills as measured by the CTBS Form U Level G. The tested null of this hypothesis states the use of computer assisted instruction is not significantly related to fifth graders' development of reading skills as measured by the CTBS Form U Level G.

Initial evaluation of this hypothesis was accomplished with the t test for independent samples using group (control/experimental) as the independent variable and change on reading score as the dependent variable. The average change-score for the fifth grade experimental group is 48.65. The average change-score for the fifth grade control group is 17.42. Independent t test results indicate there is the significant difference between these averages with the experimental group displaying a significantly higher average ($t = 3.81$; $p < .001$).

As with the first graders, when pre and post-scores for each group (experimental/control) were compared separately using the t test for paired samples, both groups demonstrated significant change (experimental group: $t = 7.44$; $p < .001$/control group: $t = 3.43$; $p < .001$). However, when these two change-scores are statistically compared to each other, the evidence points to the conclusion that the fifth grade experimental group changed significantly more than the fifth grade control group. The mean pre-, post-, and change-scores for fifth graders are displayed in Table II. Additionally, the change-data for both the experimental and control groups are graphically displayed in Figure 7.

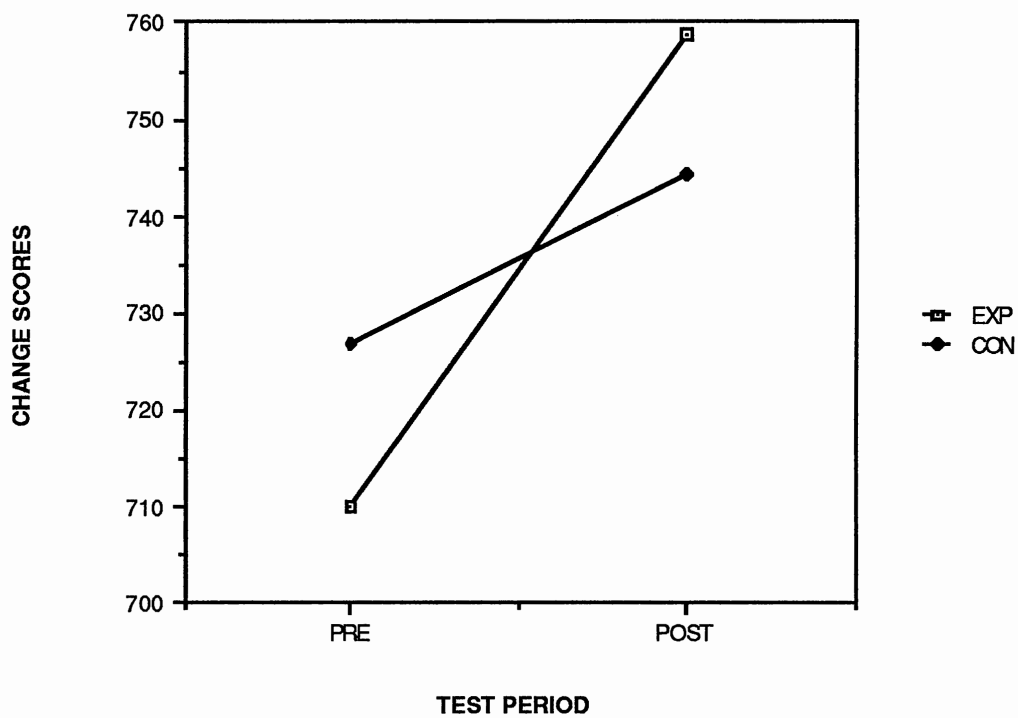

Figure 7. Plot of Pre- and Post-Scores for Fifth Graders in the Experimental and Control Groups

To ensure that the significant change observed through the use of the independent t test was not a function of unequal groups at the beginning of the school year, additional analysis was performed. First, given the significant relationship between pre-score and change-score for fifth graders (r=.46;

$p < .001$) and the significant relationship between I.Q. and change-score for fifth graders ($r=.69$; $p < .001$), a second test of this hypothesis was run holding pre-score and I.Q. constant. Specifically an analysis of covariance was run comparing the average change-scores for the two groups while controlling for pre-score and I.Q. These data are displayed in Table VII.

TABLE VII

COVARIANCE MODEL COMPARING AVERAGE CHANGE SCORES FOR THE FIFTH GRADE EXPERIMENTAL AND CONTROL GROUPS WHILE CONTROLLING FOR PRE-SCORE AND I.Q.

Source	SS	df	MS	F	Sign
Covariate					
Pre-Score	38241.18	1	38241.18	21.49	.000
I.Q.	14002.58	1	14002.58	15.36	.000
Main Effects					
Group	11409.08	1	11409.08	12.51	.001
Explained	50601.12	3	16867.04	18.50	.000
Residual	67478.73	74	911.88		
Total	118079.85	77	1533.50		

Results of this covariance model indicate there are three significant effects. First, the main effect for group is significant indicating a treatment effect. The significant treatment effect results from the fact that the experimental group has a significantly higher change-score than the control group -- even with pre-score and I.Q. controlled. Second, the covariate, pre-score, is significant, demonstrating a relationship between pre-score and change. The negative raw regression coefficient (-.612) for pre-score indicates the relationship between pre-score and change is inverse. This significant inverse relationship suggests that lower pre-scores are associated with higher change-scores. Likewise, higher pre-scores are associated with lower change-scores. Third, the covariate, I.Q. is significant, demonstrating a relationship between I.Q. and change. The positive raw regression coefficient (1.65) for I.Q. indicates the relationship between I.Q. and change is positive. This significant positive relationship suggests that lower I.Q.s are associated with lower change-scores. Likewise, higher I.Q.s are associated with higher change-scores. This three independent variable model (group, pre-score, and I.Q.) explains 43 percent of the variance in change-scores for fifth graders.

As a further test of Hypothesis 2, the average change-scores for the experimental and control groups were compared holding sex constant. Specifically, the average change-score for males in the experimental group was compared to the average change-score for males in the control group. Similarly, the average change-score for females in the experimental group was compared to the average change-score for females in the control group. The change data for males are graphically displayed in Figure 8 while the change data for females are graphically displayed in Figure 9.

Additionally, given the significant difference in average I.Q. for fifth grade females in the experimental and control groups, a fourth test of this hypothesis was made to determine if I.Q.and sex as well as pre-score were distorting statistical results. Specifically, two additional analysis of covariance models were run: the first included males only and the second included females only.

In each of these covariance models the average change-scores for the two groups (experimental/control) were compared while controlling for pre-score and I.Q. The data for males are displayed in Table VIII while the data for females are displayed in Table IX.

Males

Independent t test analysis indicates the average change-scores for males in the experimental and control groups are significantly different with males in the experimental group displaying the significantly higher average ($t = 3.28$; $p < .002$). The average change-score for males in the experimental group is 50.44 while the average change-score for males in the control group is 8.73. (See Figure 8.)

Results of the analysis of covariance model for males indicates there are three significant effects. The main effect for group is significant indicating a treatment effect. The significant treatment effect results from the fact that males in the experimental group have a significantly higher change-score than males in the control group. Additionally, the covariates, pre-score and I.Q., are significant, demonstrating relationships between pre-score and change and I.Q. and change. Since the raw regression coefficient for pre-score is negative (-.782), the relation between pre-score and change is inverse. This significant inverse relationship suggest that lower pre-scores are associated with higher change-scores. Likewise, higher pre-scores are associated with lower change-scores. In contrast, the raw regression coefficient for I.Q. is positive (2.34) indicating a positive relationship between I.Q. and change. This significant positive relationship suggests that lower I.Q.s are associated with lower change-scores while higher I.Q.s are associated with higher change-scores.

This three independent variable model (group, pre-score, and I.Q.) accounts for 51 percent of the variance in change for fifth grade males. (See Table VIII.)

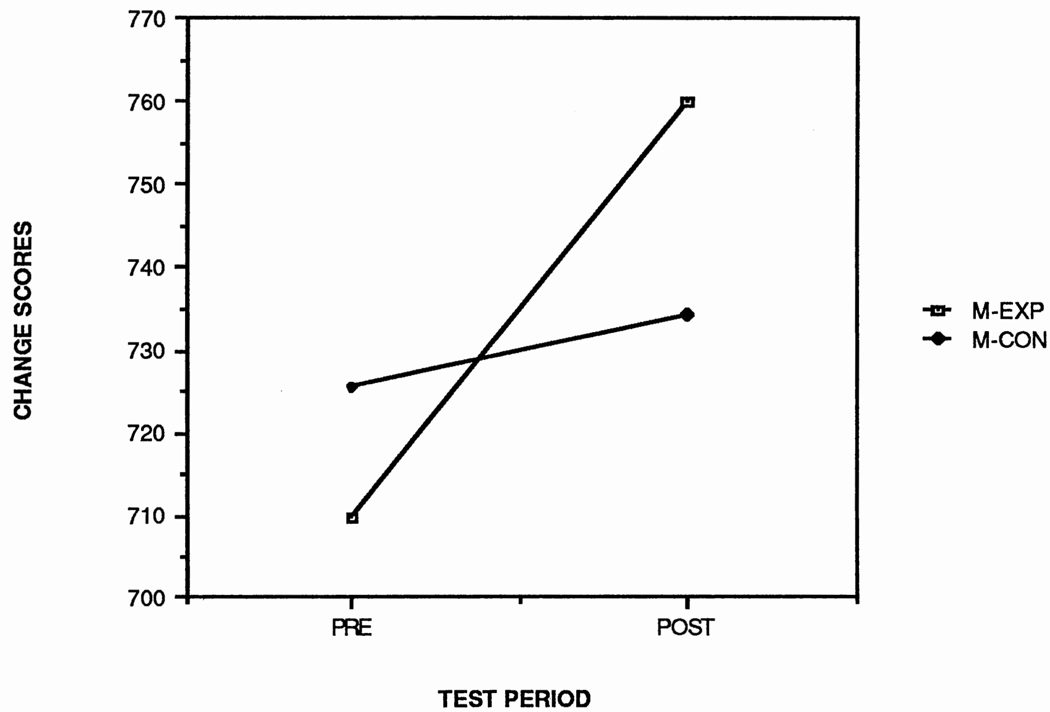

Figure 8. Plot of Pre- and Post-Scores for Fifth Grade Males in the Experimental and Control Groups

As already noted, the main effect for treatment is significant indicating there is a treatment effect among fifth grade males. In short, the significant treatment effect which was observed through the independent t test analysis is upheld with both pre-score and I.Q. controlled. These findings would suggest that those fifth grade males whose traditional classroom reading activities are augmented with computer assisted instruction will experience greater change those those males whose traditional reading activities are not so augmented. Additionally, improvement in reading skills (i.e. change) among fifth grade males is significantly related to initial reading skills and I.Q. More specifically, lower initial reading skills and higher I.Q.s are associated with greater improvement in reading skills (i.e. higher change-scores).

TABLE VIII

COVARIANCE MODEL COMPARING AVERAGE CHANGE-SCORES FOR MALES IN THE FIFTH GRADE EXPERIMENTAL AND CONTROL GROUPS WHILE CONTROLLING FOR PRE-SCORE AND I.Q.

Source	SS	df	MS	F	Sign
Covariate					
Pre-Score	39200.51	1	39200.51	34.96	.000
I.Q.	17228.89	1	17228.89	15.36	.000
Main Effects					
Group	6455.95	1	6455.95	5.76	.021
Explained	45783.62	3	15261.21	13.61	.000
Residual	44851.54	40	1121.29		
Total	90635.16	43	2107.79		

Females

Independent t test analysis indicates the average change-score for females in the experimental group is not significantly different from the average change-score for females in the control group (t = 1.62; p > .05). The average change-score for females in the experimental group is 46.95 while the average change-score for females in the control group is 32.47. (See Figure 9.)

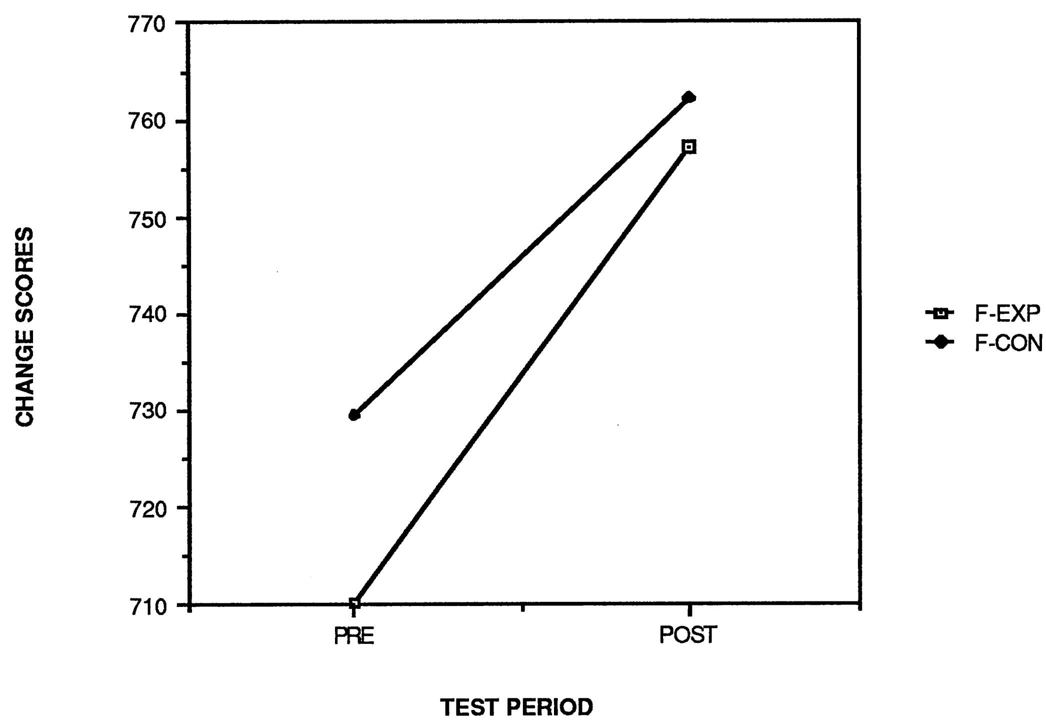

Figure 9. Plot of Pre- and Post-Scores for Fifth Grade Females in the Experimental and Control Groups

In contrast, results of the analysis of covariance model for females indicate there is only one significant effect. The covariate, pre-score, is significant, demonstrating the influence of pre-score on change. Since the raw regression coefficient for pre-score is negative (-.306), the relation between pre-score and change-score is inverse. This significant inverse relationship suggests that lower pre-scores are associated with higher change-scores. Likewise, higher pre-scores are associated with lower change-scores. This three independent variable model accounts for 27 percent of the variance in change-scores for fifth grade females. (See Table IX.)

TABLE IX

COVARIANCE MODEL COMPARING AVERAGE CHANGE-SCORES FOR FEMALES IN THE FIFTH GRADE EXPERIMENTAL AND CONTROL GROUPS WHILE CONTROLLING FOR PRE-SCORE AND I.Q.

Source	SS	df	MS	F	Sign
Covariate					
Pre-Score	3520.90	1	3520.90	4.38	.021
I.Q.	317.39	1	317.39	.56	.460
Main Effects					
Group	1312.89	1	1313.89	2.32	.138
Explained	6275.04	3	2091.68	3.69	.022
Residual	16989.35	30	566.31		
Total	23264.38	33	704.98		

The main effect for treatment is not significant indicating there is no treatment effect among fifth grade females. Likewise, the covariate I.Q. is not significant indicating this variable is not related to reading improvement among fifth grade females. In short, the significant treatment effect which was observed through the independent t test analysis disappears once pre-score and I.Q. controlled. These findings would suggest that improvement in reading skills (i.e. change) among fifth grade females is related to initial reading skills -- not treatment (computer assisted instruction/no computer assisted instruction) or I.Q. Failure to find treatment or I.Q. significant suggests that improvement in reading skills (i.e. change) among fifth grade females will occur independent of computer assisted instruction and independent of I.Q.

Summary of Findings for Hypothesis 2

In sum, results of the first covariance model which included males and females demonstrated treatment, pre-score, and I.Q. effects. This first model would suggest there is a significant difference between the average change-scores for the fifth grade experimental and control groups (males and females included) with the experimental group demonstrating a significantly higher change-score than the control group. More specifically, this model would suggest that change is related to initial reading skill, I.Q., and treatment (computer assisted instruction/no computer assisted instruction).

However, initial I.Q. differences for females in the experimental and control groups would suggest that a more appropriate model is one which examines males and females separately. Results of the covariance model for males demonstrated three significant effects: pre-score, I.Q. and treatment. In contrast, the covariance model for females demonstrated a single significant effect: pre-score.

The significance of treatment and I.Q. observed in the covariance model which included both males and females appears to be a function of the significance of these variables observed among fifth grade males. The findings of the covariance models with sex held constant suggest that the null hypothesis must be rejected for males but not for females. Restated, the use of computer assisted instruction is significantly related to fifth grade male's development of reading skills as measured by the Comprehensive Test of Basic Skills Form U Level G. Use of computer assisted instruction is not significantly related to fifth grade female's development of reading skills as measured by the Comprehensive Test of Basic Skills Form U Level G.

CHAPTER V

OBSERVATIONAL AND INFORMAL INTERVIEW FINDINGS

The purpose of this chapter is to present those findings gleaned from the many hours spent observing students and teachers and the many hours spent talking to both. Over the course of the school year, this researcher made numerous visits to the participating classrooms of both schools. Time was spent observing and talking to students when they were not involved in formal study or independent work. Additionally, several informal sessions were scheduled with each teacher in order to gain a sense of their attitudes and feelings toward both the computer assisted instruction program and the traditional reading program as it compared to the computer assisted instruction.

Teacher Attitudes Toward Computer Assisted Instruction

In general, teachers were very enthusiastic about using the computers, and there seemed to be several identifiable reasons for their professed admiration. First, the teachers' enthusiasm was largely grounded in the positive results which they saw in the form of reading improvement . Second, teachers were keenly aware of the immediate feedback which the computer provided. Third, teachers were strongly aware of the degree to which to computer was motivational. Fourth, teachers were excited about the computer's ability to tailor instruction to the individual's level. Fifth, teachers were intensely aware of the high levels of excitement which they saw radiating from their students both when they talked and when they worked in the lab. Sixth, teachers were encouraged by the increased content coverage which they view as a direct function of the computer assisted instruction. Seventh, teachers were appreciative of the positive, open, and helpful attitude held by the PLATO/WICAT company.

Reading Improvement

Several teachers commented that the computer lab had freed up quite a bit of their time since they now get grades from the computer's weekly reports. But even more important, as several teachers noted, these reports have really helped teachers to focus on where a student is having the greatest difficulty. As one teacher put it, "The biggest advantage of the computer is its monitoring of student progress." With this kind of focus, teachers can quickly revise a student's plan of study to work on problem areas. The end result is that improvement is almost always imminent. One teacher expressed it quite succinctly, "When computer assisted instruction is used, there is progress in student performance." Another teacher explained in more detail.

> The computer has really improved students' knowledge and abilities. Practice makes perfect -- opportunity after opportunity. Students who were really having difficulty in spelling, for example, showed tremendous improvement. I put their spelling words on the computer to help them learn them. Almost always the students would make 100 percent on a test. I am now a strong believer in computer assisted instruction.

One teacher took time to compare her classes' reading scores from 1984 to the present. She explained, "My early feelings were confirmed. Scores on reading tests showed tremendous increases in reading when supplemented by computer practice."

Immediate Feedback

Teachers were also quite impressed with the computer's ability to provide immediate feedback and perhaps even more impressed by the students' responsiveness to this feedback. One teacher commented, "I have seen that the computer is a great help for those students who need immediate feedback and positive reinforcement." Still another teacher remarked on the positive reinforcement in her observation that "The students liked the 'happy faces' for right answers!" This same teacher commented that reading is now her students' favorite subject. Similarly, another teacher noted, "The immediate feedback is a valuable tool. Happy faces appear on the screen, but I also see happy faces on my students."

Motivation

Several teachers were quick to realize the motivational benefits of the computer lab. This realization is especially noteworthy given the often expressed problems in the traditional classroom. As one teacher put it, "Motivation in the traditional classroom is a real problem. I usually prepare extra materials to maintain student attention and interest. Within the computer lab, the motivational factor was quite conspicuous." One teacher said, "I feel the computer is highly motivating to the students. Some skills are attacked eagerly by students when they realize they can work them on the computer as compared to a duller drill approach in the classroom." Another noted, "Many of the computer exercises are presented in a game format which in itself serves as an incentive to the students." Similarly, another teacher commented that she felt the computer provided a tremendous incentive for students to succeed.

Individualized Instruction

The teachers were well aware and appreciative of the individualized and tailored instruction which the computer provided. Their levels of appreciation were especially elevated after preparing for three reading groups each day. In talking about the traditional classroom, one teacher commented, "Individualization is a real problem. Sometimes you just have to move on." Similarly, another teacher reflected, "Reading is my favorite subject to teach, but in the classroom I don't feel as if I always meet the needs of the low and high students."

In characterizing the computer, one teacher said, "The computer is on the child's level, and it is exciting to watch the bright student proceeding at a greater pace." Another teacher commented, "The computer allows students to work at their own pace and not feel like they are in direct competition with the rest of the class." In the words of still another teacher, "The individual levels of instruction are wonderful!"

One teacher summarized this advantage when she explained, "Twenty minutes on the computer is like 20 minutes of individual instruction where in the classroom it is 20 minutes of group instruction."

Increased Coverage

A number of teachers also commented on their ability to cover more material over the course of the school year. The computer lab serves to move students through a block of material somewhat faster than the traditional classroom approach. This advantage allows teachers to branch into new horizons. As one teacher commented, "I believe the computer has been a great asset to my teaching abilities. I have been able to cover more material this year than ever before!"

Student Excitement

There is no doubt that the general atmosphere within the lab was one of excitement and pleasure. Students loved the computer lab and teachers did not fail to recognize this immediately. One fifth grade teacher commented on this energy and excitement. Of her students she said,

> My class is very competitive. They work hard to complete their lessons. One day we were going to miss computer lab due to a change in the physical education schedule. The kids were really upset! They were willing to miss P.E. in order to have computer lab that day!

From still another teacher, "Students never complain about going to computer lab. It ranks right up there with P.E." Another teacher commented, "My students are always excited about going to computers. Not one student is negative about the computer lab." Similarly, another teacher noted, "Never have I heard a negative comment such as, 'do we have to go?'" Likewise, another teacher remarked, "My children always remember computer days and they always come back (from the lab) elated." This same sentiment was expressed by another teacher when she remarked, "They (students) never let me forget when it's time to go to computer lab."

WICAT's Willingness to Listen and Make Changes

Another factor contributing to teachers' positive attitudes is the degree to which the PLATO/WICAT staff has been accessible. The PLATO/WICAT staff has been extremely responsive throughout the school year listening to both teacher and student comments and taking them to heart. As one teacher put it, "I would like to add that whenever teachers have problems, we send these to the company (PLATO/WICAT), and they have already made changes from teacher suggestions.

Summary of Teacher Attitudes

There is little doubt the majority of teachers view the computer lab as a facilitator of the learning process. In fact, one teacher paid the computer lab the highest compliment when she wistfully said, "I wish the school my child goes to had a computer lab." This positive view is widely reflected in teachers' wholehearted support of this supplement to the traditional classroom. Perhaps most importantly, teachers see the undeniable positive benefits both in the form of student energy, excitement, and attitude, and in the form of improved performance. For teachers committed to the learning process, these reasons alone would probably be sufficient to win their wholehearted support and praise.

Teacher Apprehension

It would be unfair to suggest that the teachers who were to be using the computer lab were without reservations prior to the school year beginning. Indeed, there were a number of reservations about the computer lab which teachers openly and unashamedly expressed, and these reservations were voiced for a variety of reasons.

First, teacher apprehension seemed to lie primarily in their initial fear of the machine. As one teacher put it, "I was concerned as to whether I would be comfortable with the machine." Another teacher said, "I didn't know very much about computers initially." Still another teacher noted, "I don't like 'machines' of any type." I didn't really doubt the merit of the instruction, just my own ability to understand and cope." Still another teacher indicated her initial apprehension resulted from "not knowing what to expect."

Second, there was some worry that there would be a great deal of computer "down time." Fortunately, this turned out to be incorrect, and the teachers took note of this fact. In fact, one teacher commented, "There was very little time missed because of computer 'down time'."

Third, there were some teachers who initially believed the computer would be a waste of valuable teaching time. Again, these fears were quickly alleviated as the teachers observed their students in the computer lab and as they saw the benefits of the lab work within the classroom. One first grade teacher's apprehension was expressed in the following words,

> At first I was quite skeptical about taking that much time (20 minutes per day) out of the teaching schedule. I thought it would be all fun and games and not worth the time or money. It didn't take me long before I changed my mind about the usefulness of the computer as an aid in teaching. Now I jealously guard my computer time. Every once in a while, a reading group will come to a new word and when I ask, "How did you know that word?", they answer, "We had it in computer." Now I would not like to think about teaching in a school that doesn't have a computer lab.

In short, the fears which plagued teachers before the school year began were one-by-one discounted as the data became more and more convincing. One teacher summarized the sense of ease and comfort felt by both students and teachers in her reflections on the computer lab. In describing this facility, she said, "It's wonderful! I am glad my students and I are here!"

Student Attitudes Toward Computer Assisted Instruction

In general students were very enthusiastic about using the computer. There seem to be several identifiable reasons for their professed admiration of the facility. In effect, their reasons are quite diverse and span a number of factors including the computer's frequent use of the game format, students' awareness they are learning, student control over the machine, the computer's graphics environment, the variety of lessons available, the computer's immediate feedback, the computer's patience, and the simple fact that the computer is different.

Game Format

Students were especially pleased with the game format used for a number of exercises. They frequently noted games made using the computer fun and interesting. As one student put it, "I like to play games on the computer." Another student commented, "I think that subjects are much more fun than in class because of the games." Still another student said, "Games are great because they help me learn."

Learning

Many students were cognizant of the fact they were learning through the use of the computer and a number of them noted this was their primary reason for liking it. In the words of one young lady, "It is fun because I learn a lot." Similarly, a young man said, "I feel happy and glad because it is helping me to learn more." Another student noted, "The computer has helped me learn because I can go back in where I left off." Another young lady commented, "The thing I like best is that I am learning." Still another student said, "I like the computer because it helps me in my school work." Likewise, another student said, "I like the computer because it helped me all year in my grades." Congruously, another student revealed, "The computer helped me bring my grades up."

Students also commented on the assistance which the computer provides when a student offers an incorrect answer. For example, one student said, "I love the help we get when we answer a question wrong." Another student replied, "The computer lab is a good place to learn." Still another student noted, "It is easier to learn in the computer lab."

Degree of Control

A number of students indicated they liked the computer because they felt more in control of their own learning. For example, one student commented, "I can start where I left off and this helps me to learn." Another student remarked, "I can work at my own pace." Similarly, another student echoed, "I love working at my own pace." Additionally, several students were especially complimentary of the reading comprehension module because they were able to choose personally the story they wanted to read.

Graphics Format

A number of students praised the computer pictures and graphics which were imbedded in the learning exercises. They felt these colorful pictures and graphics made the computer more fun and interesting.

Variety

Students were also quick to comment on the variety of stories which the computer provided. As previously noted, they were especially pleased that they had some control over the selection of the stories they read.

Immediate Feedback

A number of students made favorable comments on the instant feedback which the computer provides. When students answer a question incorrectly, they are told immediately that the answer is incorrect. Once students are told the answer is incorrect, they are given additional information to help them understand their mistake. In commenting on this characteristic, one student remarked, "I like knowing right then if I get the answer right."

Patience

Several students were cognizant of the extraordinary patience of the computer. The students' perceived patience on the part of the computer made it easier for them to interact with the machine. Additionally, it made them feel more at ease during their interaction sessions. For example, one student said, "When I get a wrong answer, it doesn't 'holler' at me." Another student noted, "The computer helps me learn without pushing me."

The Difference

Several students said they liked the computer for the simple fact that it was different. In the words of one student, "It was really neat and fun and different from just plain old books and paper and pencils." Another student said, "It is something different to do besides more handwritten work." Another student alluded to this difference when she said, "Writing on a computer is more fun than writing on a piece of paper."

Time Period

Perhaps one of the nicest compliments paid the computer lab came in the form of a frequent and common complaint echoed by dozens of children. This complaint centered around the small amount of computer time the classes were allotted Students frequently made comments like "I wish we had more time on the computer"; "We are not in the lab long enough"; "I wish we had an hour instead of 30 minutes"; "I don't like it when we miss computer lab"; and "I hate signing-off."

Summary of Student Attitudes

In sum, the students' positive attitudes toward the computer clearly reflect its instructional value . One boy commented, "I wish the school year would last longer so we can do more things in the lab." In reflecting on the school year, one girl said, "It was fun and I was glad to be a part of computers." Another student said, " I think that every time I use the computer it gets funner and funner and I mean that. O.K.?" Still another student commented, "I must say the computer lab was a great idea." And another student echoed, "I thought it was a privilege to work on them."

Additionally, student's positive affect for the computer lab is reflected in their positive attitudes toward themselves. One student, in her reflections, said, "Computers are one of the best things that have happened to me." Similarly, another student , in reflecting over his time in the computer lab, remarked, "I feel so good inside."

Student Apprehension

Generally speaking, students did not share the same degree of apprehension their teachers voiced at the beginning of the school year. Most students communicated a sense of readiness and excitement at the prospects of learning with the aid of a computer. When asked how she felt about the prospects of using the computer at the beginning of the year, one girl said, "I felt excited and very, very happy!" Another student echoed, "I felt proud!" In many ways they saw the computer as a toy which was simply going to be fun. One young lady said, "I thought it (the computer) would be fun and easier than written work." Another student said, "I looked forward to it everyday." In the words of one boy, "It is the greatest thing I have ever done!"

A few students openly admitted the computer was scary at first. One student revealed, "I felt a little scared and shaky." One young lady said, "At first, I was not sure what to do because I never used a computer before." Another young man noted, "I felt scared I would press the wrong button." Still another student said, "I was scared because I thought that if I did something wrong an alarm or something would go off." However, the students were also quick to add that these feelings did not last long. One boy commented "At first I didn't like it and I didn't want to go back, but now it is my favorite thing of the day."

One little girl summarized general student sentiment when she said, "I think we are the luckiest school because we have a computer lab." And in the words of one young man, "It (the computer) is probably the best thing a school could have." Similarly, another young man remarked, "I hope the computer lab will be here for years and years to come."

CHAPTER VI

SUMMARY AND CONCLUSIONS, DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

Summary and Conclusions

The purpose of this investigation was to determine whether or not the use of computer assisted instruction related significantly to development in the reading skills of first and fifth graders. To make this determination, the following steps were taken: (a) a quasi-experimental design was employed and two schools were selected -- one to serve as the experimental group and a second to serve as the control group; (b) the experimental first grade group was exposed to 60 minutes (three 20 minute sessions) of computer assisted instruction on reading per week while the experimental fifth grade group was exposed to 90 minutes (three 30 minute sessions) of computer assisted instruction on reading per week; (c) a pre-test and a post-test using the CTBS Form U were administered to both the experimental and the control groups; (d) statistical analysis was accomplished with the t test and the analysis of covariance procedures -- first, looking at each group as a whole and second, looking at each group with sex held constant; (e) informal observations and informal interactions were used to assess students' and teachers' attitude toward the computer consisting of compute. Statistical procedures were computed using the Statistical Package for the Social Sciences/Personal Computer Plus (SPSS/PC+).

Hypothesis 1

The tested null of hypothesis 1 stated the use of computer assisted instruction was not significantly related to first graders' development of reading skills as measured by the Comprehensive Test of Basic Skills Form U Level B. This hypothesis was initially assessed with change in reading scores as the dependent variable. In this initial test of hypothesis 1 an independent t test was run comparing the experimental group to the control group on the dependent variable. The findings from this analysis demonstrated the experimental group is significantly different from the control group. In effect, the t test findings suggest that the experimental group grew significantly more than the control group.

To ensure these findings were not a function of unequivocal groups at the beginning of the school year, a second test of hypothesis 1 was made using the analysis of covariance design. This design was chosen in order to control for (or remove the effects of) students' initial reading skills on change-scores. In this test of hypothesis 1, change served as the dependent variable, group (experimental/control) served as the factor and pre-score served as the covariate. The findings produced from this covariance model corroborate the findings of the earlier t test. In effect, when pre-score is controlled for, the experimental group changes significantly more than the control group.

Because of a significant difference in the initial reading scores of first grade males in the experimental and control groups, additional analysis was run holding sex constant. First, the average change-score for males in the experimental group was compared to the average change-score for males in the control group. Similarly, the average change-score for females in the experimental group was compared to the average change-score for females in the control group. Independent t test findings indicated that males in the experimental were significantly different from males in the control group with males in the experimental group demonstrating the higher average change-score. In contrast, independent t test findings indicated that females in the experimental and control groups were not significantly different. In addition to the t test analysis, two covariance models were run: one for males and one for females. When these covariance models were run with sex held constant, the findings demonstrated in the earlier t tests changed tremendously. The covariance model for first grade males demonstrated only a pre-score effect . The covariance model for first grade males did not demonstrate a treatment effect. In contrast, the covariance model for first grade females demonstrated both a pre-score effect and a treatment effect. In effect, the findings of both independent t tests with sex held constant were reversed once pre-score was controlled. These findings suggest that the null hypothesis should be rejected for females but not for males.

Hypothesis 2

The tested null of hypothesis 2 states the use of computer assisted instruction is not significantly related to fifth graders' development of reading skills as measured by Comprehensive Test of Basic Skills Form U Level G. This hypothesis was initially assessed with change in reading scores as the dependent variable. In this test of hypothesis 2 an independent t test was run comparing the experimental group to the control group on the dependent variable. The findings from this analysis demonstrate the experimental group is significantly different from the control group. In effect, the t test findings suggest that the experimental group grew significantly more than the control group.

To ensure these findings were not a function of unequivocal groups at the beginning of the school year, a second test of hypothesis 2 was made using the analysis of covariance design. This design was chosen in order to control for (or remove the effects of) students' initial reading skills and I.Q. In this test of Hypothesis 2, change served as the dependent variable, group (experimental/control) served as the factor and pre-score served as the covariate. The findings produced from this covariance model corroborate those of the earlier t test. In effect, with pre-score and I.Q. controlled, the experimental group changed significantly more than the control group.

Because of a significant difference between females in the experimental and control groups with respect to I.Q., additional analysis was run holding sex constant. First the average change-score for males in the experimental group was compared to the average change-score for males in the control group. Similarly, the average change-score for females in the experimental group was compared to the average change-score for females in the control group. Independent t test findings indicated that males in the experimental group were significantly different from males in the control group with males in the experimental group demonstrating the higher average change-score. In contrast, independent t test findings indicated that females in the experimental and control groups were not significantly different. In addition to the t tests analysis, two covariance models were run: one for males and one for females. When these covariance models were run with sex held constant, the findings of the earlier t tests remained consistent. The covariance model for fifth grade males demonstrated a pre-score, I.Q., and treatment effect. In contrast, the covariance model for fifth grade females demonstrated only a pre-score effect. In effect, these findings corroborate those of the independent t test with sex held constant. These findings suggest that the null hypothesis should be rejected for males but not for females.

Observational and Informal Interview Findings

Teachers Attitudes

In addition to the statistical findings, many hours of observation and informal interaction produced a wealth of data. In general, teachers were very enthusiastic about using the computers. Their high levels of enthusiasm and positive feelings were based on a number of emerging reasons including (a) improvement in students reading skills, (b) the computer's immediate feedback, (c) the computer's motivational ability, (d) the computer's ability to individualize instruction, (e) the students' excitement and interest, (f) increased content coverage, and (g) the positive and open attitude held by the PLATO/WICAT company.

Although teachers were highly complimentary of the computer lab and what it is accomplishing, they were not without apprehension -- at least initially. Their apprehensions stemmed largely from their own lack of experience with computers, their belief that there would be a great deal of computer "down time", and their belief that the computer was a waste of time. In short, these fears which plagued teachers before the school year began were one-by-one discounted as their observations and interactions with students became more and more convincing.

Students' Attitudes

Students were also very enthusiastic about using the computer. There were several reasons which emerged to explain their professed admiration for this facility including (a) the computer's frequent use of the game format, (b) students' awareness that they are learning, (c) student control over the machine, (d) the computers' graphics environment, (e) the variety of lessons, (f) the computer's immediate feedback, (g) the computer patience, and (h) the simple fact that the computer is different. Students' admiration was also expressed through the numerous complaints about not getting to spend enough time on the computer.

Like the teachers, many of the students experienced some initial apprehension about using the computer. Like the teachers, their fears centered largely around their inexperience with computers. However, the students were also quick to note that these fears did not last long.

Discussion

The statistical findings of this study demonstrated an interesting and discernible pattern. In each test of hypothesis 1, where males and females were analyzed together, the experimental group emerged as significantly different from the control group. Similarly, in each test of hypothesis 2 where males and females were analyzed together, the experimental group emerged as significantly different from the control group. However, once sex was held constant and covariance models were run separately for males and females, the findings changed drastically. Specifically, the significant treatment effect which appeared to characterize the total first-grade sample was found only for females. Similarly, the significant treatment effect which appeared to characterize the total fifth grade sample was found only for males.

In effect, the significance demonstrated through the treatment variable vanished for both first grade males and fifth grade females once sex was held constant. In fact, Introduction of this control produced covariance models in which treatment was significant for first grade females and fifth grade males but not for first grade males or fifth grade females. Failure to hold sex constant would have resulted in rejection of the null hypothesis for both males and females at the first and fifth grade levels -- an incorrect decision. In short, the variables which relate to change for males and females at the first and fifth grade levels are really very different and therefore, data for the two sexes must be examined independently.

The findings of this study offer support for the theoretical position that active participation is an important part of the learning process. Support for this position was found both in student performance and in students' positive attitudes toward the computer lab facility. Additionally, the observational findings of this study provide support for Bem's (1967;1972) position that intrinsic motivation develops when one can infer from his/her behavior that an activity is something he/she likes. Student comments clearly demonstrated an intrinsic interest in the computer as a learning tool. Clearly, students did not view the computer as something they were being made to do.

The findings of this study share similarities with and show differences from previous research. While gender is often an important variable in academic achievements, few published studies have rigorously addressed the issue of sex differences in computer assisted instruction. When sex differences have been examined, research has indicated that males achieve more than females (Neimiec and Walberg, 1985). Most published studies addressing the role of computer assisted instruction in the learning process, even those using more rigorous research designs, either have compared students using computer assisted instruction to those students who are not or have compared students using computer assisted instruction before and after some computer instruction is introduced. This type of analysis places males and females in a single group and any differences which are a function of sex are concealed.

The statistical findings of this study corroborated, in part, those findings of published research which has clearly validated the importance of computer assisted instruction in the learning process. More specifically, the findings of this study corroborated those of Donahoo (1986) who reported the use of the PLATO/WICAT computer system in a Chicago school for one class at each grade level from kindergarten through grade eight resulted in significant gains at every level on the 1985 Iowa Test of Basic Skills. However, Donahoo did not examine his data for males and females separately. Hence, there is no way to determine the role of gender in his findings.

The significant treatment effect for first grade females and fifth grade males suggested that grade, as well as sex, may be an important consideration in understanding the role of computer assisted instruction in the learning process. This interpretation finds support in Stoneburg's (1985) finding that second graders improved more than students in other grades in the area of mathematics. One can only speculate as to why this gender reversal occurs at the two different grade levels. Conceivably, first grade females have not yet been subjected to the forces of socialization which suggest that computers are more interesting to males. If this mindset has not yet developed, then females would be expected to relate well to computers as a learning device. Conceivably, by fifth grade, females have been socialized to believe that computers are of more interest to males. If this belief has been internalized by females, they may not be as interested in computers as males, for any reason, learning or otherwise. This interpretation finds some support in the research of Williams (1984) who found no difference in the frequency of computer use between preschool boys and girls.

At the first grade level, initial reading ability may also influence the extent to which computer assisted instruction can be effective. Conceivably, there may be an optimum score or range of scores, which when achieved, result in a more effective learning process through computer assisted instruction. More specifically, the lower initial reading scores of first grade males in the experimental group may have placed them at a starting position, when compared to the male control group, that made it difficult for them to catch up and move ahead -- regardless of the medium used While this argument might have validity at the first grade level, it does not appear feasible at the fifth grade level -- since females in the experimental group have very similar pre-scores to the rest of the fifth grade sample. Conceivably, females have a greater interest in school in general, and hence, are able to respond to any learning medium. If this argument were valid, both media (computer assisted instruction and the traditional classroom) would produce very similar results -- thus, rendering the treatment no more effective (and no less effective) than the traditional classroom.

It was noteworthy that the attitudes of both males and females at both grade levels were quite positive. There was no noticeable gender difference as measured through energy, excitement, and interest displayed both in and out of the lab. Hence, if gender socialization was operating in fifth grade females, it was not openly discernible.

Aside from the statistical findings there was some evidence which might be interpreted to suggest that computer assisted instruction is influential in the learning process. More specifically, an examination of change-scores reveals that among first grade males in the experimental group, only one male regressed in reading ability as measured by the difference between the pre and post-scores. In contrast, six first grade males in the control group regressed.

Similarly, no first grade females in the experimental group regressed while five first grade females in the control group regressed. An examination of change-scores for fifth graders reveals this same pattern for males. Specifically, only one fifth grade male in the experimental group regressed in reading ability while six fifth grade males in the control group regressed. In contrast, no fifth grade females in the experimental group regressed and no fifth grade females in the control group regressed. This latter finding lends credence to the argument that females have a strong interest in school in general and hence, respond to any medium which fosters learning.

While this evidence of regression in reading skills can not be interpreted as conclusive proof of a treatment effect, it is evidence of a difference worth noting. Conceivably, the importance of computer assisted instruction lies not only in its ability to increase significantly the reading skills of a large number of students, but also in its ability to reduce substantially the number of students who regress in their reading skills.

In addition to the treatment effect (computer assisted instruction versus traditional classroom methods), for first grade females and fifth grade males, the findings of the covariance models for fifth graders clearly demonstrates the influence of initial reading skills on reading improvement. In all of the covariance models where this variable was introduced, initial reading skill emerged as a significant predictor of change-score (i.e. improvement in reading skills). Essentially the significance of initial reading skill suggest that a student's initial reading score is significantly related to improvement in reading skills. More specifically, this finding suggest that those students who start with lower reading scores will experience greater change. This interpretation seems quite logical in light of the fact that those students with the lowest scores have the most to learn if they are to catch up. Additionally, in the covariance model for fifth grade males, I.Q. emerged as a significant predictor of change-scores. The significance of I.Q. suggest that those males with higher I.Q.'s experience higher change-scores. Restated, this findings suggest that males with higher I.Q.'s experience greater improvement in reading skills than males with lower I.Q.'s. Again, this interpretation seems quite logical in light of the fact those those males with higher I.Q.'s are more likely to absorb a greater percentage of what is taught to them.

The importance of initial reading skills in predicting reading improvement is quite logical and predictable. In fact, it must be remembered that reading improvement is being predicted for all students in this study -- both those in the experimental group and the control group. In short, the significance of initial reading skills as a covariant of reading improvement applies to both the experimental and the control group. Hence, this variable is a covariant of reading improvement both in the traditional classroom and in the traditional classroom which is supplemented with computer assisted instruction.

It might be argued that the increases in the CTBS scores for first grade females and fifth grade males are a function of a testing effect. However, if this were the case, one would also expect the same testing effect in the appropriate control groups since they were also tested at the beginning of the school year. Since the two groups started the school year as equals, an increase in both groups which was a function of testing would result in the two groups scoring higher but equal at the end of the year. However, statistical analysis demonstrated that the two groups were not equal at the end of the school year. Hence, while some part of the change may have been a function of testing effect, there still remains some part of the change that appears to be a function of something else -- conceivably, the use of computer assisted instruction.

It might also be argued that the increases in reading skills experienced by the first grade females and fifth grade males in the experimental group were a function of their greater interest. In fact, this interpretation finds support in many of the comments made by teachers and students. Conceivably, as reading concepts were being taught in the classroom, the computer experience made the classroom activities more meaningful and relevant. This meaningfulness and relevance might be reflected in the increased interest in learning reading. Similarly, this increased interest could account for the increased scores. If this argument is valid, and this study cannot decide this issue, the computer must still be given some credit, even if indirectly, for its part in helping to increase the student's interest.

The observational findings of this study suggest that computer assisted instruction enhances the teaching experience for teachers. The weekly printouts allow teachers to identify more quickly those problems which students are having. Teachers also find that they can cover more material in the same allotted time. The observational findings of this study also indicate that computer assisted instruction produces positive attitudes in students toward learning. It also appears that once these positive attitudes develop, they tend to persist. These positions are suggested by the many teachers and students who interacted with the computer. What's more, the observational findings of this study suggest that students' interactions with the computer are often followed by feelings of positive self worth.

In sum, the findings of this study suggest that computer assisted instruction can enhance both the teaching and the learning process for some individuals. The unique characteristics of the computer would seem to allow for new educational strategies to be devised in which the interaction between the student and the learning material is both attractive and effective.

Implications

Reading is a unique process that allows an individual to utilize skills to receive and decode information stored from past experience and knowledge. Effective reading skills are essential to career success and personal growth. Certainly reading is a prime contributor to learning as a lifelong process.

Students are more unique and complex than the nature of reading itself, thus lending mystery and excitement to the instruction continuum. Activities reflective of individual student interests and capabilities should be honored through the effective and affective use of interest and computer assisted instruction offers no exception.

Educators should possess specific skills while striving to understand as much as possible concerning the nature and science of reading. In effect, educators should be willing to seek continual educational growth through computer training, inservice staff development, and professional associations. Such educators, striving for excellence with positive attitudes and healthy self-esteems, are important to all schools since it is their behavior which is emulated in the lives of students.

If computer assisted instruction is a viable and profitable educational tool for the present and the future, teachers must become involved in this medium of learning. This involvement will mean becoming knowledgeable with respect to computers as learning tools. It will also mean clocking many hours of "hands on" experience in order to more fully know and evaluate the extent to which these machines can or cannot help the student.

Teacher educators also need to be concerned with developing attitudinal readiness for using this technology. It can be anticipated that technology will take an increasingly active role in the educational and teaching process of the future. If this is to be a reality, it is important for future teachers to begin their professional careers with an open attitude toward using and integrating computers into the school curriculum.

An individual is a child only once, and many of the teaching opportunities with which a teacher is provided are given only once. It becomes the teacher's responsibility to maximize each and every learning opportunity. If the computer is a viable medium for teaching the student, no less can be done. Every learning opportunity involving the computer must also be identified and maximized. The future of this nation depends upon it.

Recommendations

Computer assisted instruction is an important learning tool. If one attends to the wealth of literature being generated today, it is a learning tool whose time has come. It is also a learning tool which appears to be grounded in sound psychological and learning principles. If the findings of this study are taken seriously and to heart, more computer assisted instruction is needed in this nation at every grade level. In view of this study, the following recommendations are made:

1. A longitudinal study needs to be done. This study should collect several years of skill data prior to the introduction of the computer and several years of skill data following introduction of the computer.
2. Any longitudinal study needs to assess students at all elementary grade levels.
3. A quasi-experimental study needs to be done which includes all elementary grade levels.

4. More in-depth study is needed of teachers' attitudes toward the computer and the extent to which teachers' attitudes and experiences influence students' attitudes.
5. There is a need to study students' attitudes and the extent to which their attitudes influence their overall performance.
6. There is a need for an in-depth study on "What is Wrong" with computers to ensure that they reach their maximum potential as educational tools.

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VITA

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Candidate for the Degree of

Doctor of Education

Thesis: THE RELATION OF COMPUTER ASSISTED INSTRUCTION TO THE DEVELOPMENT OF READING SKILLS IN FIRST AND FIFTH GRADERS

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