An Analysis of Concept Mapping as an Instructional Technique for Teaching Advanced Technology Concepts to At-Risk Junior High School Students

by

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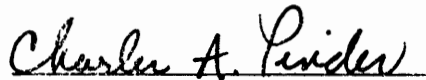in partial fulfillment of the requirements for the
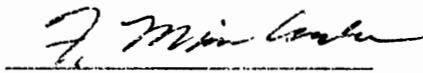
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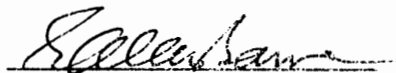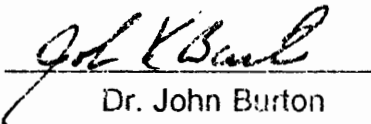*Charles A. Pinder*

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(ABSTRACT)

The purpose of this study was to determine the effectiveness of concept mapping as an instructional technique for teaching advanced technology concepts to at-risk junior high school students. The students were from three Northern Illinois school districts, 174 students from three junior high schools. The study sought to assess the effects on achievement of students who used concept mapping as part of a carefully designed sequence of instructions.

Method and Procedure

Eight intact junior high school technology classes, taught by three instructors, took part in this study. Of the 174 seventh and eighth grade students participating in this study, 87 students were in the treatment groups, and 87 students were in the control groups. The intact groups were formed

from two schools with three classes and one school with two classes. Within

each school, classes were randomly assigned to be the treatment groups or

control groups. The criteria for student selection for the at-risk group were

based on (a) students' attendance, (b) students' behavior, (c) personal history,

(d) counselor's input, and (e) parent conferences. The at-risk students were

identified by a code only known by classroom teachers. The quasi-

experimental design used for this study was the pretest-posttest design. A

two-way ANCOVA using the pretest scores as a covariate analyzed the

posttest scores to determine what effect, if any, distinguished between the

instructional methods.

Results

There was one main finding of this study. The benefits of using

concept mapping appeared for the at-risk students than for the not at-risk

students.

Conclusion

For this junior high school at-risk population, concept mapping during

and after instruction led to greater achievement as measured by posttest.

Acknowledgements

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Dedication

To my loving wife, Jan Spivey Gilchrist, and my two children, Ronke and

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CHAPTER I

INTRODUCTION

Today's students live in a changing society continually bombarding them with an enormous amount of new facts. Their survival in this technologically driven society directly relates to their ability to internalize, process, store, and recall new information effectively. The ability to process information effectively is now the foundation of the American workplace. Naisbitt pointed out that "now more than 65 percent of us work with information as programmers, teachers, clerks, secretaries, [and] accountants" (Naisbitt, 1982, p. 4). Only individuals who are able to process efficiently and to communicate effectively will share in tomorrow's world.

These facts are especially frightening for increasing numbers of high-risk students attending secondary schools. Whether labeled "new," "disadvantaged," "nontraditional," "remedial," or "developmental," these students are all weak in such basic skills as science and mathematics. Debate has long driven education's efforts to address the needs of its at-risk

students. However, concerned educators recognize that the solution to the troubling problem offered by today's at-risk students is not found by denying access to high-level problem solving skills or by lowering academic standards. Denying access to critical thinking skills is an inappropriate response to the challenges offered by students unprepared for today's job market (McCade, 1982, p. 27).

Moreover, in recent years, educators have also become increasingly accountable for what takes place in the classroom. Expectations are that teachers will somehow provide students with skills to master factual knowledge, and will also teach students strategies to apply to new skills, enabling them to use, analyze, and synthesize new situations (Hodgkinson, 1987, p. 2).

One instructional technique that addresses the specific needs of at-risk students and promises to prepare them for our technology driven society is concept mapping, suggested by Ausubel, Novak, and Gowin, who have studied the process by which children attain knowledge. In his discussion of Piaget and Inhelder, whose work paved the way for Ausubel, Novak, and Gowin, Langer (1984) concluded that the force that directs development is the dynamic interaction between the child's cognitive structures and environmental data. Throughout children's early years, they continually

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develop and modify schemes generally defined as organized behavioral patterns of internal representations of rules and items of information: "They [schemes] constitute the stuff out of which the child's knowledge is made" (p. 2). The child's capacity to coordinate and combine schemes increases with age. Piaget refered to the mental space in which this integration of data takes place as a "field of equilibrium" (p. 5). Parallel and/or sequential activation of schemes already in the child's mental capacity can be used. The mental space is a set measure of the maximum number of schemes or "discrete chunks" of information that the child can attend to, integrate, or coordinate at any time during the problem solving process (p. 12).

Novak purported that a person's understanding of a concept changes as he or she associates it with a wider array of concepts and specific propositions. Concept mapping records the individual's organization of schemes into a two-dimensional diagram that reflects the relationship of new and old information. A vast amount of research has used the "hierarchical structure"; that is, concept maps are organized with the most general, most inclusive idea at the top or apex of the map, with successively less general, less inclusive concepts in appropriate subordinate positions. Concept mapping can serve as a kind of "rubber sheet," where we can "lift up" any

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concept on the sheet and thus create a new hierarchical relationship between linked concepts (Novak, 1984, p. 632).

Bruner (1960) contended that the heart of any discipline consists of a series of major ideas or relationships that explains the facts of that particular field. These major ideas or relationships constitute the structures of the disciplines. Bruner pointed out (p. 7) that unconnected sets of facts "have a pitiably short half-life in memory." Bruner's work in concept development convinced him that these fundamental ideas, or concepts, could be taught to almost every child at any age and ability level in some intellectually honest manner.

The Research Problem

The major purpose of this investigation was to determine whether concept mapping may enhance the learning of advanced technology concepts for all student populations, with specific emphasis on at-risk students.

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Research Questions

The research questions for this study were the following:

1. Is there a difference in the level of acquisition of selected advanced technology concepts between those students who participate in the concept mapping strategy program vs. those who do not participate?

2. Is there a difference in the level of acquisition of selected advanced technology concepts between at-risk and not at-risk students as identified by teachers?

3. Is there an interaction between at-risk classification of students and the concept mapping treatment in terms of mean scores on a test of selected advanced technology concepts?

Purpose and Significance of the Study

This study provided empirical data dealing with how students learn advanced technology concepts with special focus on at-risk students. Few data exist to describe the performance of at-risk students in technology

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courses.

This study was significant as the first to investigate the viability of the use of concept mapping in technology classes and also provided data on at-risk students.

Limitations of the Study

The following limitations were identified in this study:

1.   The population was selected from pre-existing classes.

2.   The same technology teacher taught both the experimental and control groups.

Delimitations of the Study

The following delimitations were identified in this study:

1.   The study was limited to three schools and three teachers in the State of Illinois.

2.   The study was limited to seventh and eighth grade students.

3.	The students in the treatment groups were exposed to four concept

mapping activities.

Definition of Terms

The following definitions were used for this study:

1.	**Technology** -- "the study of the creation and utilization of adaptive

systems and the relation of the behavior of these systems and

elements to human beings, society and the environment" (DeVore,

1988).

2.	**Advanced Technology** -- "is the latest technological advances of the

day in any technology area" (Goetsch , 1988, p. 29).

3.	**Advanced Technology Concepts**--"a commonality in events or

objects indicated by some label that identifies the latest technological

advances of the day."

4.	**At-Risk Student** -- "any student who fails a course in school, is

retained in grade, or drops out of school, uses drugs, has been

physically or sexually abused, or has contemplated or attempted

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suicide" (Frymier and Gansneder, 1989, p. 143).

5.   **Concept** -- "a regularity or commonality in events or objects indicated by some label" (Novak & Gowin, 1984, p. 47).

6.   **Concept Map** -- "a schematic device for representing concepts and their relationships" (Novak & Gowin, 1984, p.54).

7.   **Proposition** -- "two or more concepts labels connected by linking words" (Novak & Gowin, 1984, p. 48).

8.   **Quasi Experimentation** -- "experiments that have treatment outcome measures, and experimental units, but do not use random sample assignment to create the comparisons from which the treatment caused changed is inferred" (Cook & Campbell, 1979, p. 6).

9.   **Hierarchy** -- "any system that starts with the most general concept at the top and proceeds downward to the most specific concepts" (Bousquet, 1982, p. 14).

Summary

How students learn advanced technologies is an important topic for

research. An in-depth study of learning styles and strategies that may improve advanced technology comprehension among students labeled at-risk will be useful to many educators. The results should interest all individuals involved in the process of educating our nation's children. In addition, the levels of authentic achievement of the at-risk students will enable educators to make knowledgeable decisions about technology instruction.

Concept mapping is one learning style that has produced exciting results in fostering meaningful learning among students (Novak, Gowin, and Johansen, 1983, p. 625). Concept mapping is a visual, two-dimensional diagram of the interrelationship between concepts. A review of the literature indicates that most studies have been conducted with white, rural, or affluent suburban populations. This study explored a cross-section of students with emphasis on at-risk students. The purpose of this research was to determine whether concept mapping may enhance the learning of advanced technology concepts for all student populations, with specific emphasis on at-risk students.

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CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

An increasing number of mathematics and science teachers are experimenting with a teaching method called Concept Mapping. Concept Mapping is a visual representation of the relationship between old and new information held by an individual. Teachers who use concept mapping agree that their students comprehend newly taught information at a higher level. This literature review focuses on the use of concept mapping in the areas of science and mathematics.

The literature on concept mapping focuses on defining the different learning styles and the approaches used by researchers. Often, classroom teachers regularly encounter students unable to understand a particular subject concept carefully taught to them.

Defining Advanced Technology

The nature of our technological society is marked by unrelenting

change. Technological growth is vital to all individuals in this rapidly changing

world. Humans are the focal point of all that we do in technology. As

individuals develop from childhood to adulthood, they will interact with a series

of technological devices ranging in complexity from simple to advanced.

Dugger (1988) traced the etymology of the term "technology" to its

roots in the Greek words "techne" and "logas." "Techne" relates to the art or

craft in making something, and "logas" deals with the understanding or logic of

the art, craft, or skill.

Donald Maley (1983), Professor Emeritus and former department

chairman at the University of Maryland, pointed out that "technology with

respect to the development of the human component must deal with the

process of learner development in systematic inquiring, problem solving,

analyzing, synthesizing, and generalizing" (p. 7).

Technology Education has been defined as "a comprehensive, action-

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based educational program concerned with technical means, their evolution, utilization, and significance; with industry, its organization, personnel, systems, techniques, resources, and products; and their social/cultural impact" (ITEA, 1985, p. 25).

Devore, in a recent speech, explored the different areas of technology instruction. He defined technology as "the study of the creation and utilization of adaptive systems and the relation of the behavior of these systems and elements to human beings, society and the environment" (Devore, 1988).

The Virginia Technology Education Department defined technology as the "study of the application of knowledge, creativity and resources to solve problems and extend human potential" (1988, p. 3).

Webster's Dictionary defined technology as "(1): technical language, (2a) applied science (2b) a scientific method of achieving a practical purpose, (3) the totality of the means employed to provide object necessary for human sustenance and comfort" (1989, p. 1211).

Goetsch (1988) has worked in the field of engineering, exploring future trends. He defined advanced technology as "the latest technological advances of the day in any technology area" (p. 29).

Defining At-Risk Students

Many defining labels characterize the literature that describes at-risk students. It appears that there were some concerns for poor children about two hundred years ago. In 1805, before there were public schools in New York, the New York City Free School Society asked the state legislature to establish a special school for poor children (Cuban, 1989, p.10).

Carnegie conducted an extended study exploring the socially disadvantaged. He defined socially disadvantaged individuals as "people who differ from each other in a number of ways but have in common such characteristics as low economic and social status, low educational achievement, tenuous or no employment, limited participation in community organization and limited ready potential for upward mobility" (Colling, 1984, p. 10).

Gilmour et al. (1974) defined the at-risk student as one who does not meet traditional middle-class standards. They pointed out that the early decisions concerning the child's ability will influence the kind and quality of education received as well as future educational aspiration. "Tracking"

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students insures failure and acts as a self-fulfilling prophecy for at-risk learners (Gilmour, et al., 1974, p. 10).

A recent study of 22,000 students by Phi Delta Kappa defined at-risk students as children who are likely to fail either in school or life. The study suggested that any student who fails a course in school, is retained in a grade, or drops out of school is at-risk. Likewise, a student who uses drugs, has been physically or sexually abused, or has contemplated or attempted suicide is also an at-risk student (Frymier and Gansneder, 1989, p. 142).

By 1987, the term "at-risk" student had come into common usage. Federal and state legislation emphasize both educational and economic criteria with emphasis on minorities. Dryfoos estimated that seven million children, one in four of those aged ten to seventeen, are in jeopardy of not growing into responsible adults who can effectively parent, work, or vote. These high-risk youngsters simultaneously are most likely to be in trouble with the law, to abuse drugs, to become premature parents, and to be low achievers. These young people live in very stressful circumstances. They lack the vital supervision that effective parents provide. This does not imply that the situation of a single parent should be automatically added to the list of at-risk children. Despite the conventional wisdom that equates at-risk with

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minority status, the majority of at-risk children (4.8 millon of 7 millon) are white (Dryfoos, 1990, p. 120). However, the probabilities of falling into the at-risk group are significantly higher for African Americans and Hispanic Americans between the ages of 10-17 years, reflecting some correlation between poverty, poor neighborhood quality,and ethnicity (p. 121).

Frymier stated that being at-risk is not solely a phenomenon of adolescence. Children of all ages are at-risk. A six year old whose parents are in the middle of a divorce and who is doing poorly in school is at-risk. A seventeen year old whose grades are good but who is deeply depressed because she just lost her boyfriend is also at-risk. A ten year old whose father just lost his job is certainly at-risk (p. 143).

The U.S. Census Bureau figures (1990) revealed that nearly half of the heads of poor households are employed. Sherraden observed that most people who live below the poverty line are not welfare recipients and are considered members of the underclass. They have jobs or are members of a household in which someone has a job. Some of the workers in these families are children and teenagers. In 1989, the U.S. Department of Labor discovered 23,000 minors working in violation of the Fair Labor Standards Act. Child labor violations have doubled in the last five years. Many of these

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children are at-risk students in schools (Reed and Sautter, 1990, p. 782).

The literature presents much speculation but little hard evidence about learning styles of at-risk students. Wynn identified three thinking patterns that may influence learning: (1) inadequate attention to details of the problem to solve, (2) inadequate utilization of knowledge, and (3) absence of a sense of relationship among the ideas involved (Wynn, 1975, p. 23). Many educators suggest that the at-risk student has an over-reliance on memorization, a lack of insight, and the inability to transfer internal information. A question for technology educators is how to move students from memorizing facts to thinking about concepts and understanding relationships between them as the process unfolds. Many educators assume that every student is capable of conceptual thought. Technology educators expect students to make the transition from facts memorized in science and math courses to conceptual implementation in technology courses. Many students adequately accomplish this. For the at-risk student, however, this can present a serious roadblock to meaningful learning.

Some students continue to have difficulty with educational curriculum, even after the teacher feels confident about his/her students' comprehension. For the at-risk students, new content material may cause problems. Many of

these students fall further behind the more knowledgeable students. Teachers attempting to understand the students' successes and to deal with their failures should consider more fully the variations in what students know (Raines, 1983, p. 2).

Spillane in a recent speech on at-risk students stated:

> If educators take the position that a child is incapable of learning until (all) needs are met, we may doom the child never to learn because poverty will persist, divorce will persist, sickness and human tragedy will persist. Ideally, a child comes to our classrooms well-fed, warmly-clothed, and securely-loved. But this is not an ideal world, and these are not prerequisites to learning; to believe that they are contributes to the "lowered expectation syndrome" that depresses student achievement. In actuality, academic achievement could be the only tangible success in an otherwise defeating existence, as well as the only way out of that existence. (Spillane, 1987, p. 23)

Ausubelian Cognitive Learning Theory

While many investigators recognize different types of learning, Ausubel (1961) distinguished clearly among several principal kinds of learning (rote and meaningful, concept formation and assimilation, and verbal and nonverbal problem solving) that take place in the classroom. Distinctions can be made between reception and discovery learning and between rote and meaningful learning (p. 18).

Ausubel (1968) stated that the principle underlying learning and instruction is the following:

The most important single factor influencing learning is what the learner already knows. Ascertain this, and teach him or her accordingly. The learner's present knowledge base influences not only the new information that he or she recognizes but also the interpretation given to the new information through relating it to existing knowledge. There are differences both in method of encounter and in process of giving meaning during learning (p. 142).

During reception learning, one explicitly describes the new information

and its relation to existing concepts to the students. Ausubel explained:

The principal content of what is to be learned is typically presented to the learner in more or less final form. Under these circumstances, the learner is simply required to comprehend the material and incorporate it into his cognitive structure so that it is available for either reproduction, related learning, or problem solving at some future date (1980, p. 83).

During discovery learning, the student seeks new information and establishes its relation to prior knowledge. The student may then be given the accepted label for the information. Ausubel, Novak, and Hanesian (1978) stated that the difference between reception learning and discovery learning "inheres in whether the principal content of what is to be learned is discovered by or is presented to the learner" (p. 27).

All meaningful learning, acquired by any variation in mode from reception through discovery, involves a degree of discovery in that the learner actively establishes a relation between new information and existing knowledge and does so in a totally random manner. Meaningful learning for Novak (1979) is "always idiosyncratic and in this sense the learner 'discovers'" (p. 476). Ausubel (1980) contended that new information acquired by meaningful learning is stored in an altered form and modifies existing

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concepts to which it is linked. The same new material can be learned in a meaningful way by one person and rotely by another, because the new material may be substantially differentiated in one individual but not in another. In Figure 1, Ausubel developed a chart that illustrates the key concept that one needs to consider when facilitating meaningful learning. This chart shows how learning becomes less rote and more meaningful when instruction encourages subsumption, integrative reconciliation, superordinate learning, and progressive differentiation and uses advance organizers.

Concept Learning

Ausubel's (1978) cognitive learning theory has been a guide to much of the current research on concept teaching. He defined the notion of "concept" in the following terms: "....[any] objects, events, situations or properties that possess common critical attributes and are designated in any given culture by some accepted sign or symbol" (p. 30).

LONG TERM INFORMATION PROCESSING

ACCORDING TO AUSUBEL'S THEORY

Meaningful Learning--New Knowledge is consciously linked to existing specifically relevant concepts and propositions in cognitive structure and incorporated into these concepts.

Learning moves higher on the rote--Meaningful continuum when the following processes are facilitated.

Subsumption--Incorporation of new knowledge into a specifically relevant existing concept or proposition.

Integrative Reconciliation--New learning that results in explicit delineation of similarities and differences between related ideas.

Superordinate Learning--New concepts or propositions acquired that relate the meanings of two or more related, less inclusive ideas.

Progressive Differentiation--Elaboration and clarification of meanings of concepts or propositions occurring over time as new subsumption, integrative reconciliation and/or superordinate learning occurs.

Advance Organizer--A brief, meaningful learning task designed to help the learner link new specific knowledge to relevant concepts or propositions he/she already knows.

Rote Learning--Arbitrary, verbatim incorporation of new information into cognitive structure.

Figure 1

Key Concept in Ausubel's Assimilation Theory
(Source American Biology Teachers, 42 (5), 1980, p.282.)

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The principal ways in which concepts are acquired are concept formation and concept assimilation. Concept formation requires direct experience with objects, events, or properties from which common features are abstracted through a form of discovery learning.

This type of concept acquisition usually takes place in a preschool environment. However, older children and adults acquire concepts through a process of concept association and eventually of assimilation. Individuals learn new meaning by being presented with the common features of concepts and by relating these features to established ideas in their cognitive structure (Ausubel, et al., 1978, p. 31).

One of the main themes throughout the research is Ausubel's learning theory that emphasizes that humans think with concepts. Very little rote learning takes place in the child's early life that is not associated with a previously held idea. Students acquire a large diverse data base of alternative conceptions before and during their school years, and these ideas often resist their replacement. Rather than isolated ideas, many of these ideas form part of a larger conceptual framework that provides an organized view of the society. Students often digest only those aspects of a new concept that are consistent with previously held ideas (Dekkers & Malone,

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1984, p. 220).

Once concepts are acquired, they serve many purposes in cognitive functioning. They are used in learning related new meanings and in solving problems. Like Ausubel, who stressed the importance of concepts, Novak supported the contention that concepts in cognitive structure facilitate meaningful learning, which subsequently fosters the further development of those concepts and leads to increased potential for problem solving in any specific area of study.

Some of the variations in students' performances during problem solving activities are due to differences in their present knowledge base. Differences in student performance may also be due to the new relations, unique to the learner, established between pieces of information in a new problem and developed in part through prior experiences with problems.

If a student related a new problem to previously held information not directly involved in a meaningful solution, the student may be unable to solve the specific problem. For this student, problem solving may involve noticing some information, finding the information to be related to nothing else in existing knowledge that seems useful, and failing to solve the problem. The less successful problem solver may also resort to assigning individual,

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arbitrary meaning to the information in a problem in an effort to remember it.

A student who relates information in a problem to existing knowledge that includes the facts and processes needed for the solution is more likely to solve the problem successfully. For this student, problem solving is an opportunity to assimilate problem information and to develop even more useful concepts. Additional experiences with problem solving may result in meaningful learning for the successful problem solver, while tending to result in rote learning for the less successful one.

Concepts developed from perceived regularities in events are somewhat characteristic of the learner and therefore do vary from person to person in their detail and in their relation to other concepts. If the concepts include relations essential to the construction of the solution, the student has something to work with cognitively to develop the solution. The student who fails to become conscious of problem similarity involving important, useful information may not be developing concepts potentially useful for problem solving (Raines, 1983, p. 3).

As Novak (1977b) has indicated, the principal structure for a discipline may be supplied by the major concepts in the discipline. Furthermore, if a student learns how concepts are derived, then this learning may lead the

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student to an understanding both of the concepts and of the structure of the discipline. Novak's theory of education has placed concept learning in school. He took the position that "concepts are primarily what we think with, that concept learning is the principal function of schooling" (1984, p. 460).

Much of school learning identifies and develops the meanings of concepts. For example, most of the material taught in schools is in the form of propositions, composed of concepts that in combination take on new meanings. The learning of new propositions requires learning new concepts that are components of the proposition as well as understanding the special meaning of the proposition itself. Ausubel's cognitive learning theory states that the key factors in the meaningful learning process are the relevant concepts or propositions the individual possesses (Novak, Gowin, and Johansen, 1983, p. 636).

Gowins' work, Educating (1981), provided a way of "getting smart" about educative events while emphasizing meaningful learning. His sense of educating was the following:

an eventful process which changes the meaning of human experience

by intervention into the lives of people with meaningful materials, to

develop thinking, feeling and acting as habitual disposition in order to

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make sense of human experience by using appropriate criteria of excellence (p. 35).

According to Colling (1984), education is an eventful process, an intervention designed to change the meaning of experience for learners. Events become the focus for attention. Educating, then, really means changing the meaning of human experience. After a person has been involved in a structured educative event, the meaning of learning has changed for that person. Sharing learning so that we can be involved in the same process of learning makes educating possible. Gowin (1981) emphasized that as they construct meanings, learners begin to understand their own power and begin to move into possession of the world they inhabit. Useful understandings are social constructions that allow students the opportunity to tie things together in our world (p. 40).

Grasping the meaning of educative materials is fundamental to the educative process. Gowin stressed that this is the responsibility of the individual that he or she cannot share. Learning takes place after active reorganization of an existing pattern of meaning by the learner. He emphasized that learning is never entirely cognitive. In educating at-risk students, the integration of thinking, feeling, and acting is essential. Learning

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can have feelings without meanings and meanings without feelings, but when both merge in a powerful educative moment, connections between thinking, feeling, and acting are occurring (p. 43).

Gowin (1981) further believed that education leads to self-understanding and to the exercise of emotions, intellect, imagination, judgement, and action. Educative processes generate "human capital" as well in that they lead to gains for both learner and teacher. Ideas generate more ideas, values generate values, caring generates caring, and educating generates further educating in a "multiplier effect." Significance becomes the value concept for the increase in meaningful connections in experience (p. 44).

Colling (1984) believed the process of concept formation begins in young children as a sort of discovery learning involving hypothesis generation and testing as well as generalization from specific instances. She cited as an example an infant's first experience with a male labeled "da-da." This continues with every male being "da-da" until the corrected toddler is able to recognize that other "da-das" are "uncle" or "grandpa." Gradually, the young child discovers the critical attributes that characterize the concepts of daddy, grandpa, and uncle, and appropriately applies their language labels. After a

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child has acquired through concept formation one or two thousand concepts as a functional vocabulary, additional differentiation and development of new concepts occur principally through assimilation (p. 54).

Repeating of words, sharpening understanding of simple concepts, and refining appropriate language labels become primary tasks of the pre-schoolers. The child learns that the context of concept usage is also important. For example, a "dead-end street," a "dead battery," and a "dead person" mean very different things. Novak (1979) pointed out that the conceptual ontogeny of the individual proceeds, not in a definite pathway, but rather in a pattern determined by the transection of experience the child has had in encounters with evolving cultural heritages (p. 55).

Ausubel's "meaningful learning" (assimilation of new experiences with existing relevant concepts in cognitive structure) becomes idiosyncratic, as cognitive structures that develop meaningfully incorporate new experiences. Such development is dependent on past sequences of experiences and ethnic background. By school age, most children have an adequate framework of concepts to allow meaningful reception learning to proceed (Colling, 1984, p. 56).

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Concept Mapping

Novak (1984) began concept mapping as a way to improve meaningful learning. After a "decade" of attempting to assess "change in cognitive structure as a result of meaningful learning," Novak and his team developed the technique they called concept mapping (p. 609).

Concept mapping, an instructional technique and learning strategy, attempts to help students learn concepts in the meaningful way described by Ausubel. Essentially, a concept map is a diagram, produced by a student or teacher, that indicates relationship among concepts in a given area of study (Ausubel et al., 1978).

This instructional technique and learning strategy, designed according to these theory-based criteria and used in the concept mapping process, was developed and is being assessed by Novak at Cornell University. Simply, a concept map is a diagram that indicates relationships among concepts in a discipline, a part of a discipline, or an interdisciplinary area of study. A map will depict not only a concept but also propositions that describe meaningful relationships between pairs of concepts. A teacher, a student, or a group of

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students can construct a concept map.

Figure 2 shows the structure of a concept map with sixteen concepts, four levels of hierarchy, three main branches, and two cross links. The most inclusive concepts appear at the top of the map. As one progresses down the map, the concepts become less inclusive and more specific. Unlike an outline, a concept map is two-dimensional. This characteristic allows the portrayal of the complex connections that exist among concepts (Novak, 1984, p. 611).

When one looks at a concept map, the most general and inclusive concepts appear at the top of the map. Each level of the hierarchy contains concepts of the same order of generality. The degree of differentiation among concepts is indicated by the branching of the concept map. Cross links are relationships between concepts on different branches and show the degree of integration of concepts.

Because each person possesses a unique organization of concepts and propositions in his or her cognitive structure, a concept map that is meaningful to its maker may not be the most meaningful arrangement to another person. There is thus no single "correct" concept map; the best maps
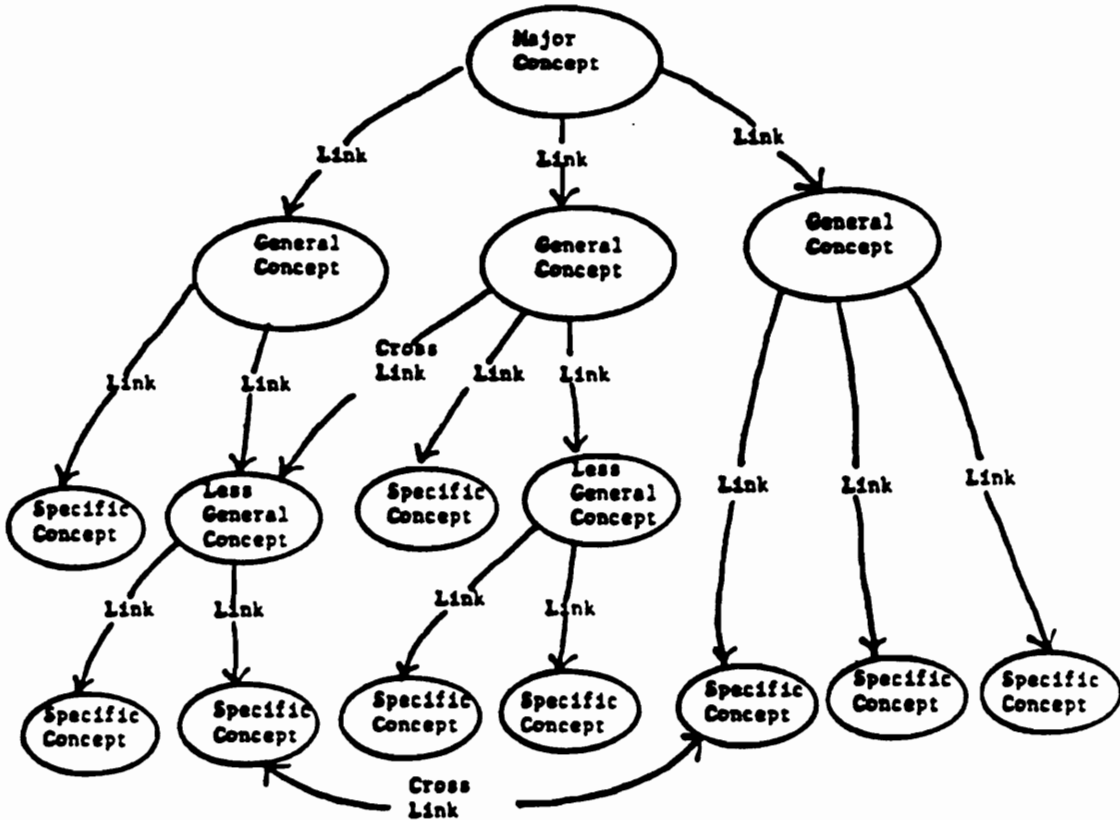
Figure 2

The Hierarchical Structure of a Concept Map

are most meaningful to persons who construct or read them. Each map

should also meet the following criteria:

1. Concepts are arranged in a hierarchy; i.e., the map starts with

    the most general concepts at the top and proceeds downward to

    the most specific concepts.

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2. Related concepts are linked by lines (principles) that show these relationships.

3. Each principle has a label that describes how the linked concepts are related, a preposition (Bousquet, 1982, p. 76).

This procedure asks learners to identify concepts, decide which are more general, and move to the more inclusive and meaningful concepts as they relate to each other. Concept mapping, once mastered, has the potential to become a strategy that students can use to learn the concepts of any area of study in a meaningful way. Figure 3 is an example of a concept map of a concept map. Novak and Gowin (1984) observed that often students enter into a laboratory or field setting wondering what they are supposed to do or see; their confusion is so great that they may not get as far as asking what regularities in events or objects they are to observe, or what relationships between concepts are significant. As a result, they proceed blindly to make records or manipulate apparatus with little purpose and little consequent enrichment of their understanding of the relationships they are observing and manipulating. Concept maps can help students identify key concepts and
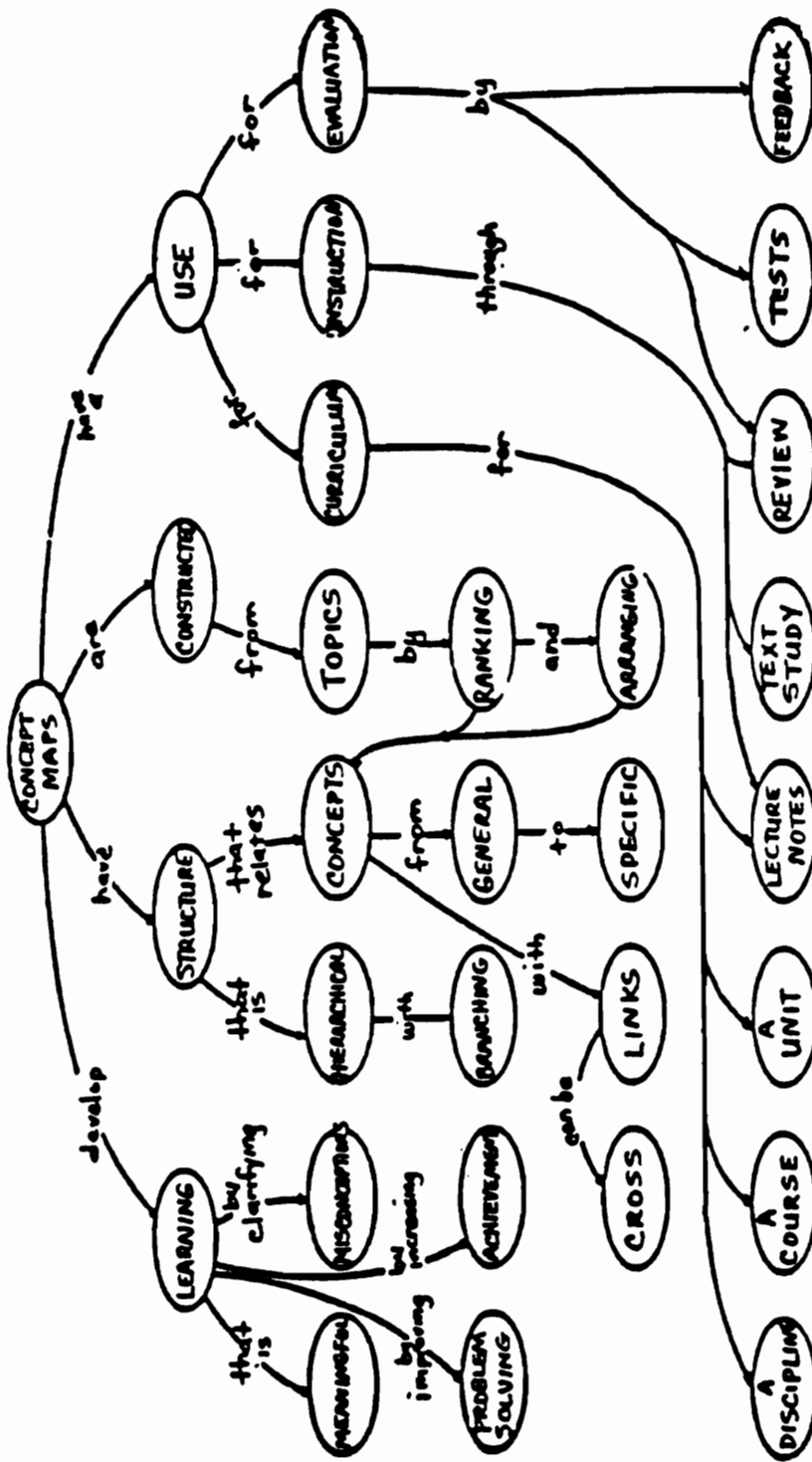
Figure 3. A Concept Map of Concept Maps.

Source Building an Organized Knowledge Base: Pankratius, W., 1987. p. 73.

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relationships, which in turn will help them to interpret the events and objects they are observing (p. 87).

Toulmin (1972) defined concepts as patterns or "regularities" in events or objects. Objects are simply defined as "things" and events as "happenings." Concepts are denoted by names, symbols, or signs of our language. We use concepts when we observe or interpret events and objects. They help us describe and explain the way the world works. We cannot see a concept the way we see an object or experience an event. The object "my dog" evokes an image of a particular dog. The concept "dog" reveals an image of the characters or regularities that identify the concept of dog. Each person's concept (of dog) may differ slightly from everybody else's concept to some extent depending on experience, context, or perspective. There are usually enough shared regularities among people's concepts so that they can communicate. We think with concepts. Meanings of our concepts of events and objects change over time as we learn about a wider variety of examples and as we relate concepts to other concepts in new ways (p. 347).

In recent studies (1984, 1985, 1986, 1989) conducted by Loncaric, Pankratius, Carter, Novak, Hawk, and Okebukala & Jegede, they examined

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the effects of a concept mapping teaching strategy program on experimental

and control groups of students. The studies explored urban high school,

college, and rural elementary school students, concluding that students

involved in concept mapping activities showed greater achievement as

measured by posttest scores.

Two studies conducted by Rhoneck and Carter (1984, 1985) showed

no significant difference between experimental and control groups. Three

studies showing inconclusive data (1984, 1986, 1989) conducted by Colling,

Stice & Alvarez, and Anderson & Huang all used experimental and control

groups.

Summary

Concept mapping is still a relatively new area of study. Do the

advantages of using concept mapping justify the expense of in-servicing staff

and students? Given the state of public school education for low-achieving

students, it is clear that research in this area is well worthwhile. The

advantage of this approach is it can pinpoint specific weaknesses, thereby

identifying the need for remedial action.

Concept maps have been called the "windows of the mind" of the students we teach: for seeing in (by the teacher and other students), for seeing out (by the students), and for reflecting on one's own perceptions (by everybody). These maps facilitate a sharing of meaning unhampered by any lack of verbal skills. Consequently, both teacher and students are able to judge with some degree of clarity how well they themselves have grasped a particular concept and how well their classmates have done also (Dekkers & Malone, 1984, p. 220).

CHAPTER III

THE DESIGN AND METHOD OF THE STUDY

This chapter describes the design and method of this study including

the subjects, research design, general procedures, instrumentation, and

hypotheses.

The Sample

The sample for this study consisted of all seventh and eighth grade

students attending suburban public junior high schools in 3 school districts

located in the northern Illinois area. Of the 174 seventh and eighth grade

students participating in this study, eighty-seven students were in the

treatment group, and eighty-seven students were in the control group. The

students were enrolled in intact technology classes. The intact groups were

formed from two schools with three classes of seventh and eighth grade

students and one school with two classes. Within each school, classes were

randomly assigned to be the treatment or control group. In school "A", two

classes were experimental, and one was control. In school "B", two classes

were control, and one class was experimental. In school "C", one class was experimental, and one was control.

The student populations of the three school districts are discussed below:

School District # 1 serves children from kindergarten through the eighth grade. There are five elementary schools and one junior high school. The ethnic makeup of the student population is 82% African American, 13% caucasian 4% Hispanic American, and 1% other.

School District # 2 serves children from kindergarten through eighth grade. There are twelve elementary schools and four junior high schools. The ethnic makeup of the student population is 51% caucasian 42% African American, 5% Hispanic American, and 2% other.

School District # 3 serves children from kindergarten through eighth grade. There are five elementary schools and two junior high schools. The ethnic makeup is 51% African American, 42% White, 7% Hispanic American, and 1% other.

While there were eight intact classes from three different school districts used in this study, the researcher observed that the ethnic makeup of the industrial technology classes did represent the ethnic composition of the respective school districts.

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Design of The Study

The treatment group students in these junior high industrial technology classes were exposed to four learning activities involving concept mapping exercises over a six-week period. Students in the treatment group were not randomly chosen. The industrial technology classes were intact and self-contained.

The concept mapping activities that students were exposed to in this study were developed by the researcher and teachers. These activities were part of a unit taught to both the experimental and control groups. Teachers involved with this project participated in an eight-hour inservice session on the development of the concept mapping techniques. The inservice session instructed teachers to provide the goals of the concept mapping units to the students.

The treatment group received instruction in concept mapping and constructed concept maps during and after learning units and activities. The control group participated in the same learning units and activities at different times, but did not construct concept maps. These students were either

seventh or eighth grade students enrolled at the same schools as the treatment groups. The effectiveness of the use of concept mapping in the acquisition of the researcher-designed advanced industrial technology concepts was determined by comparing scores on an objective test achieved by the treatment group with scores of the control group.

Hypotheses

This study addressed three hypotheses, each drawn from the research questions presented in Chapter 1:

Hypothesis 1. There is no difference in the mean scores on a test designed to measure the acquisition of selected advanced technology concepts between students using concept mapping (experimental group) and those not using concept mapping (control group).

Hypothesis 2. There is no difference in the mean scores on a test designed to measure the acquisition of advanced technology concepts between at-risk and not at-risk students.

Hypothesis 3. There is no interaction between at-risk classification of

students and the concept mapping treatment in terms of mean scores on a test of selected advanced technology concepts.

Research Design

The design used for this study was quasi-experimental, using the pretest-posttest design with nonequivalent groups. Figure 4 shows the diagram for this design. The diagram shows that (1) two groups (treatment and control) are used; (2) X is the advanced technology concept mapping activities given to the treatment group; (3) both groups are measured (0) at the same time before and after the concept mapping activities have been conducted on the treatment group.

Experimental   O X O
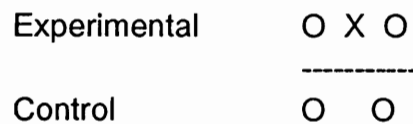
Control   O   O

Figure 4. Nonequivalent Control Group Design

Threats to both internal and external validity were of major concern for

this study. Best (1989) listed seven threats to internal validity; these include

maturation, history, testing, experimental mortality, experimenter bias,

unstable instrumentation, statistical regression, and selection bias (p. 118).

The advanced industrial technology concepts study addressed the internal

threats as follows:

This study was conducted during a six-week time period, and the

possible maturation threat in this study was controlled by this short period of

time. The history threat was minimal during this study. The researcher

checked each school calendar, for special changes, events, such as fire drills,

tornado drills, etc. The researcher checked the local community calendar of

events planned that may have affected the subjects involved in the study.

The researcher monitored the different schools for any catastrophic events in

the school and community that might have significantly affected the test

performance of any participating group. There were no major events in the

three school systems. Such events could have affected the external validity

of this study.

The testing in this study consisted of a pretest and a posttest. This

study used intact groups having experimental and control groups. The pretest

had 10 general questions included to make the pretest appear different from

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the posttest, and enabled students to correctly answer some questions. Responses to these questions were not included in future analysis.

This study experienced a 10 student loss from pretest to posttest. These students were from both the experimental and control group equally. Experimenter bias was addressed by having the students identified by a code known only to the classroom teacher. The researcher only received data related to the subjects involved in this study. The researcher made several visits to classes during the study to observe the teachers and their presentations.

Unstable instrumentation was addressed by field testing with sixty students not involved in the study. A panel of experts reviewed questions and made recommendations. The results received from the field test and panel were analyzed by a statistical reliability test.

The statistical design used in this study was Analysis of Covariance (ANCOVA). According to Cook (1979, p. 170), the analysis of covariance with a single covariate extends the analysis of variance (ANOVA) by including the pretest measure in the model in the form of a linear regression. Using the pretest scores directly in the model provided an adjustment for pre existing differences between groups.

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General Procedures

The three school districts were identified by the researcher with the aid of several technology teachers. Initial contacts were made with the central office of each participating school district. The superintendents identified in writing the schools approved to participate in this study, as directed by the district's school boards. The researcher and local school principals met, to identify the participating classes. After they identified the sample of participating classes, teachers, principals, and supervisors met to establish the starting date of the study. Individual meetings and inservice training with teachers were conducted before the study began. At each of these meetings, the proposed research was explained and endorsements sought from the appropriate individuals.

This study also relied on the instructor's identification of at-risk students. The criteria for student selection to the at-risk group were based on (a) student's attendance, (b) counselor's input, (c) student's behavior, (d) class work, (e) personal history, (f) parent conferences, (g) examinations, and other criteria determined by classroom teachers. The students identified as

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at-risk were coded and known only by the classroom teachers. The researcher used only raw scores and data submitted by classroom teachers.

Development of Instruments

This study examined the acquisition of advanced industrial technology concepts. The activities examined the external and internal components and operations of a computer system. The computer systems used during the activity phase were I.B.M. clones. The Gil-Tech I (pretest) content areas were general information, hardware (external), software, peripheral devices, and hardware (internal). The questions appear in appendix B.

The Gil-Tech II (posttest) questions examined the level of acquisition of advanced technology concepts as it related to instruction given to students. The Gil-Tech II (posttest) examined the following areas: (a) hardware (external), (b) software, (c) peripheral devices, and (d) hardware (internal). The questions appear in appendix C.

The test instruments were developed by the researcher with the assistance of a panel of experts in the technology field. The Gil-Tech I (pretest) and the Gil-Tech II (posttest) were the same examination. The Gil-

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Tech I consisted of 35 questions, with 10 general questions not included or scored on the pretest. The Gil-Tech II examination consisted of 25 questions.

The Gil-Tech I (pretest) consisted of 16 true/false and 19 multiple choice questions. The Gil-Tech II (posttest) consisted of 9 true/false and 16 multiple choice questions. The Gil-Tech I examination measured the student's initial knowledge relating to the advanced technology units of study. The Gil-Tech II examination measured the acquisition of advance technology units of study after instruction. The Gil-Tech II (posttest) consisted of 8 questions relating to the software, 8 questions relating to the internal components, 6 questions relating to the external components, and 3 questions relating to peripherals.

Instrument Review Panel

The instrument questions were analyzed by a panel of experts in the field of computer science and technology. In order to be selected, each panelist had (a) to be a college graduate, (b) to hold a current teaching license, and (c) to have a minimum of three years' experience in the technology and computer science field.

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The instrument examination was reviewed by a panel of individuals

selected by the researcher. The purpose of this panel was to certify the

content validity of the questions. The panel reviewed and evaluated (a) goals

of the study, (b) objectives, (c) activities to be concept mapped, (d) and

pretest instrument. The panel reviewed and made suggested additions and

deletions from a table of specifications. The purpose of the table of

specifications was to ensure that test items matched the learning activities

planned for this study matched what the instrument was designed to examine.

Reliability Assessment

The instrument review panel and researcher developed an instrument

with forty-nine possible questions. The Gil-Tech 1 instrument was then tested

with sixty students from a local school. The tests were scored, and those

scores were analyzed for internal consistency reliability. Initially, the Gil-Tech

1 pretest had forty-nine questions. Twenty-four of these questions had low

inter item correlations--i.e., scores below .80, and were eliminated from the

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examination. This resulted in a twenty-five-item test with an alpha coefficient of .82 with a mean of 13.62 and standard deviation of 2.77. The results appear in Table 1.

Collection of Data

Individual instruments for students were disseminated and collected by classroom teachers. The classroom teacher conducted and supervised the learning units and the concept mapping activities. Individual schools, teachers, and students participated on a voluntary basis. All students' maps had anonymity.

Analysis of the Data

Analysis procedures included the calculation of descriptive statistics and frequencies for all variables in the study. Further, analysis of covariance tested for any statistically significant differences between groups at the 0.05

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Table 1

<u>Reliability Results for Posttest</u>

Group	N	Reliability	Mean	Max/Mim
Posttest	60	.82 (alpha)	13.62 (2.77)	20.00/8.00

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alpha level. The SAS statistical software package (Freund, 1988) computed the analysis of covariance (ANCOVA). This study used intact groups and was therefore not a true experimental sample. The inferential statistics--i.e., analysis of covariance (ANCOVA)--was used to provide an indication of effects, given the assumption that these groups were typical of students that might be randomly sampled.

Summary

This chapter delineated the design and method of this study, which included the ethnic and demographic areas of subjects used in this sample population, research methodology, general procedures, instrument validation, hypotheses, and analysis of data. This study used a sample of 174 seventh and eighth grade students attending suburban junior high schools in the northern Illinois area. A quasi-experimental design used in this study employed pretest and posttest with nonequivalent groups. The eight classes of students were taught by the three technology teachers at their respective schools. Two schools had three technology classes, and one school had two

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technology classes. The technology teachers taught both the control and

experimental classes. The technology classes were randomly assigned to the

experimental or control condition.

CHAPTER IV

ANALYSIS OF DATA

Descriptive Data

Presented in this chapter are empirical data, treatment group mortality,

instrument reliability, and tests of hypotheses related to this study. To

conclude the chapter, there is a summary of findings. Initially, 174 students

participated in this study and were administered the pretest. Only 164

students were administered the posttest. This resulted in a group mortality of

10 students. Five students from both the experimental and control groups

who did not take the posttest were excluded from the final analysis.

The students used in this study were seventh and eighth graders. The

classes were randomly assigned to either experimental or control conditions.

Eight intact classes were used at three different junior high schools. The

teachers identified the students' risk status. The participants were 104 (60%)

males and 70 (40%) females. There were 111 (64%) eighth graders and 63

(36%) seventh graders. There were 106 at-risk students and 58 not at-risk

students involved in this study. The means corresponding to each level of the

experimental variables appear in Table 2. The data show the mean scores for

both the pretest and posttest groups for risk and treatment status. The means

provided in Table 2 suggest that the percentage increase in the scores of at-

risk students was greater than increases in the scores of not at-risk students.

The mean pretest and posttest scores for both control and

experimental groups are graphically represented in Figure 5. On average,

there was a 3.44 point increase from pretest to posttest scores for all groups.

The posttest scores for the at-risk experimental group averaged 4.88 points

higher than their pretest scores. The posttest scores for the at-risk control

group averaged 3.17 questions higher than their pretest scores. The mean

gain (posttest minus pretest) scores for the at-risk students who received

treatment showed an 6.8% gain.

Table 2

Pretest and Posttest Mean Scores

Factors	N	Pretest	N	Posttest
At-Risk Exp.	60	9.80 (2.96)[1]	57	14.68 (2.13)
Not At-Risk Exp.	27	11.25 (3.35)	25	15.04 (3.06)
At-Risk Control	52	8.19 (1.73)	49	11.36 (2.03)
Not At-Risk Control	35	10.14 (2.25)	33	14.06 (2.57)
Total	174	9.61 (2.771)	164	13.62 (2.772)

[1] numbers in parentheses are Std. Dev.
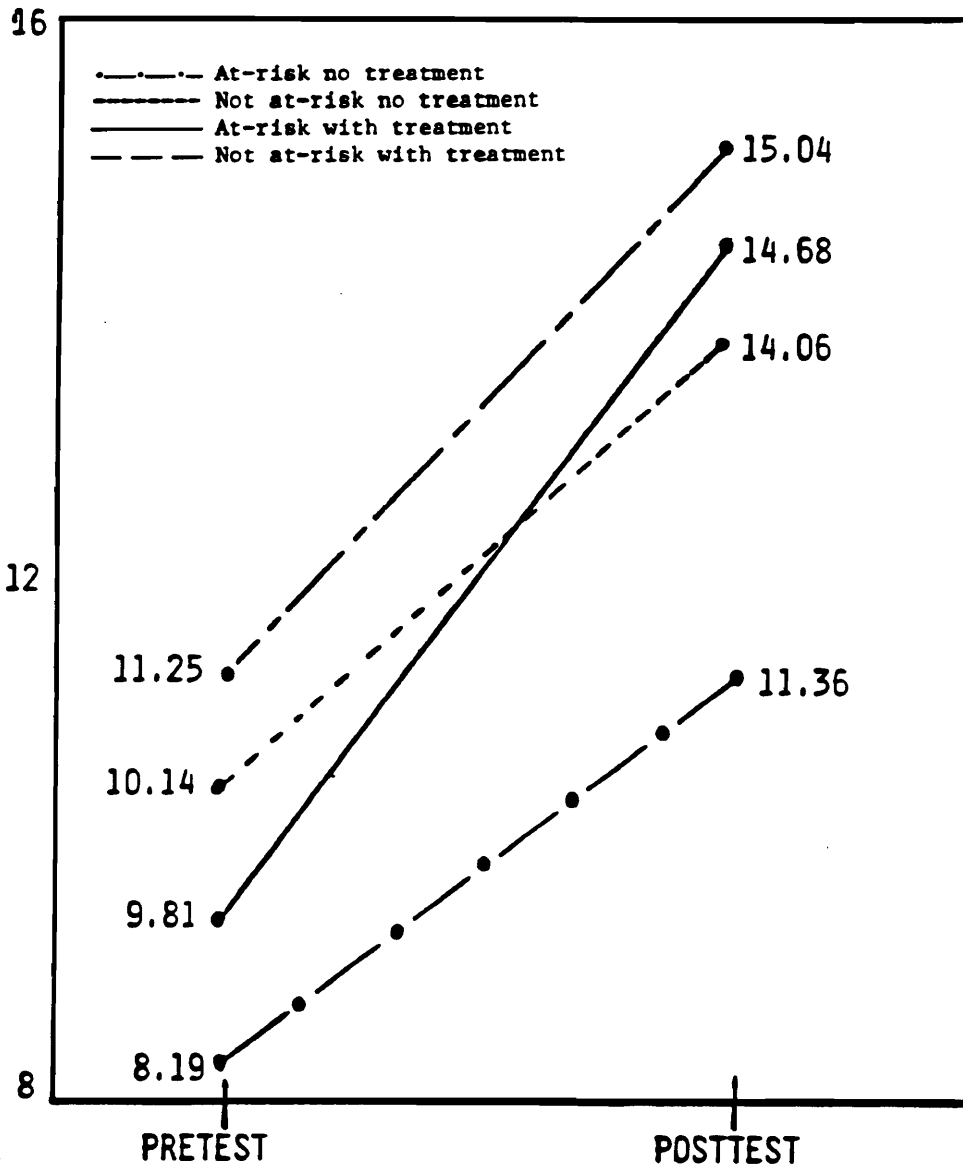
Figure 5
Mean Pretest and Posttest Scores by Instructional Treatment

Test of Hypotheses

The researcher analyzed the scores of the students by using analysis of covariance with two between-subjects factors and one covariate. The between-subject factors were treatment and at-risk status, and the covariate was pretest scores. The use of ANCOVA permits a post-hoc statistical control for one or more variables, essentially removing their influence from the comparison of groups on the experimental variable of variables. The use of ANCOVA in the present study adjusted posttest scores to account for differential performance on the pretest. Since this study used intact groups, however, it should not be assumed that experimental and control groups were equalized on other unknown variables that may have affected posttest performance. The model was fitted with the main effects, covariate and the interaction between the experimental variables. This model explained 39% of the variation in the data, which was significantly greater than 0 ($F = 25.02$, df = 4,159, $p < .05$).

The analysis of covariance (ANCOVA) data for this model appears in Table 3. As seen from Table 3, the interaction between the independent

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variables were significant. It appeared from the data in figure 5 that the at-risk experimental group benefitted more from the treatment.

As shown in Figure 6, there seems to be a difference between the posttest mean scores of the control and experimental groups. As a result of the significant interaction, the calculation of the simple main effects was necessary. Therefore, the researcher computed simple main effects for each level of treatment within the at-risk and not at-risk conditions The simple main effects showed that the treatment was significant ($F = 20.867$, df = 1, 159, p. < .05) for the at-risk experimental students. The simple main effects showed that the treatment was not significant ($F = .5616$, df = 1, 159, p. < .05) for the not at-risk experimental students. Concept mapping helped the at-risk treatment group significantly.

The hypothesis states that there would be a differences between at-risk and not at-risk students' scores on a test designed to measure the acquisition of selected advanced technology concepts. The results of the simple main effects did support this alternative hypothesis after the researcher rejected the null hypothesis.

Table 3

Two-Way ANCOVA of At-Risk Status and Treatment on Posttest Scores

using the Pretest as the Covariate

Source Value	DF	SS	Mean Square	F
At-Risk	1	29.77413802	29.77413802	6.16*
Treat	1	93.60062483	93.60062483	19.36*
At-Risk*Treat	1	42.76915710	42.76915710	8.85*
Pre	1	113.8226712	113.8226712	23.54*

* p < .05.
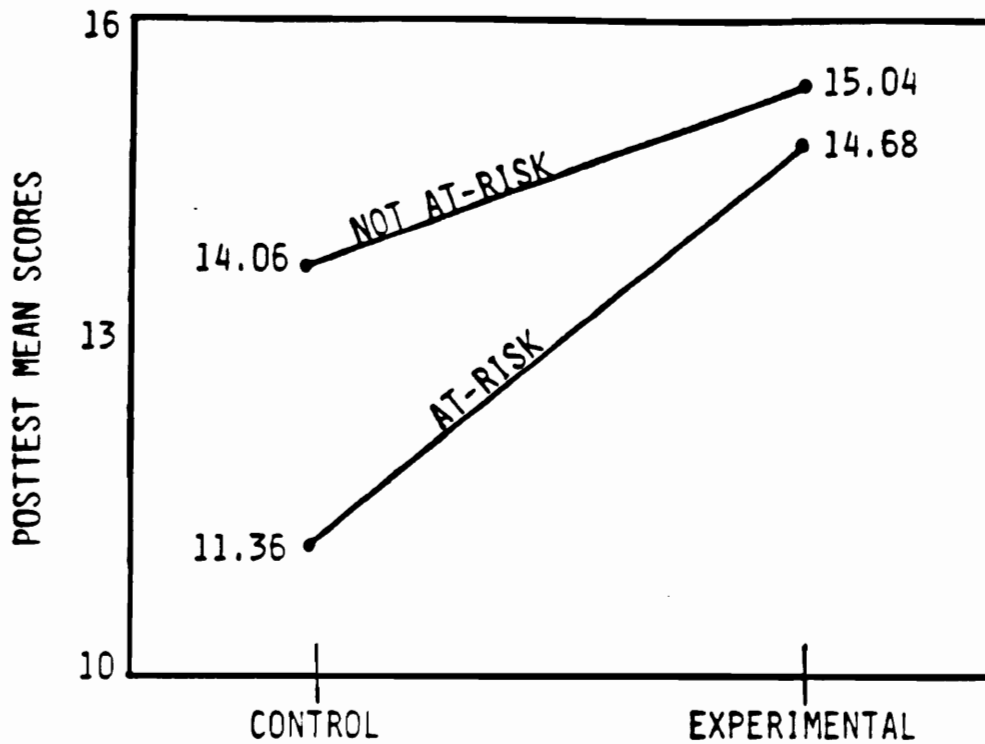
Figure 6

Effect of Instructional Strategy of Concept Mapping
and Risk Status

Summary of Results

Initially, 174 students took the pretest examination. However, due to

an attrition of ten students, only 164 students took the posttest. The three

teachers were interviewed to ascertain the reason for the attrition rate. At

school "A", four students did not take the posttest. The teacher stated that two students were sick and one was suspended. The fourth student was absent with no reason given. Three students were in the control group, and one was in the experimental group. At school "B", there were five students out for the posttest. According to the teacher, two students were out sick, two students were absent, and one student was suspended from school. Four of the students were in the experimental group, and one student was in the control group. At school "C", one student in the control group was out because of illness.

The researcher analyzed the adjusted posttest means to ascertain whether there was an difference in treatment effects within risk status. A test of simple main effects indicated a significant effect for at-risk students (p. < .05), that led to the rejection of the null hypothesis.

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CHAPTER V

DISCUSSION CONCLUSIONS AND RECOMMENDATIONS

The present study addressed the effectiveness of concept mapping, as a teaching technique for improving learning in at-risk students. The main finding of this study was that concept mapping was effective for at-risk students but not for the not at-risk students. This section discusses the implication of the preceding result.

Restatement of the Problem

The major purpose of this investigation was to determine whether concept mapping would enhance the learning of advanced technology concepts for all student populations, with specific emphasis on at-risk students.

Restatement of the Research Questions

The research questions for this study were the following:

1. Is there a difference in the level of acquisition of selected advanced technology concepts between those students who participate in the concept mapping strategy program vs. those who did not participate?

2. Is there a difference in the level of acquisition of selected advanced technology concepts between teacher identified at-risk and not at-risk students?

3. Is there an interaction between at-risk classification of students and the concept mapping treatment in terms of mean scores on a test of selected advanced technology concepts?

Discussion

Kolde (1991) stated that technology education must become an educational delivery system and not a just a content area. Technology educators must use a variety of approaches, such as applied learning, concept formation, and experimentation. She believed this will encourage

students to learn how to learn.

The purpose of this investigation was to study the effects of concept mapping on achievement. The concept map, postulated as an effective learning tool, by giving at-risk students a means to organize their knowledge base regardless of their level of achievement.

The Gil-Tech tests were difficult and exceptionally challenging for most junior high school students. The Gil-Tech II (posttest) instrument was analyzed for its readability level by using the software package RightWriter. The Gil-Tech II (posttest), as indicated by RightWriter's software, was rated at an reading level of 8.3. Although this instrument was at grade level for some students participating in this study, it was above many other students' reading levels. Some of the variation in students' pretest performances may be also to differences in existing knowledge and reading levels.

The introduction of these instructional units for the not at-risk and at-risk students showed that the mainstream students scored higher on the pretest. Both the control and experimental groups improved, but the at-risk students using concept mapping had a substantially higher pretest to posttest score percentage increase. The results indicated that concept mapping can increase learning with at-risk student populations.

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An important benefit exhibited by the use of concept mapping by at-risk students was their achievement of almost normal learning levels.

MacLachlan (1986) stated that sometimes relatively small differences in the way information is presented and internalized can lead to substantial improvement in learning by at-risk students. MacLachlan identified a technique that has led to heightened learning, which he called "curiosity to learning" (p. 66). Students at the junior high school level begin to develop an increase in curiosity to learning new knowledge. Most students at this grade level begin to take ownership for their learning. Not at-risk students have usually developed learning strategies to aid their heightened curiosity. Often, at-risk students have not developed these skills; even though their curiosity to learning is still intact, many at-risk students have not capitalized on the skills necessary to develop this desire.

In this study, using instructional programs like concept mapping with at-risk students enabled them to use their existing knowledge base. The at-risk student's ability to assimilate new knowledge with prior knowledge worked for the at-risk students in this study. The results showed that concept mapping enabled at-risk students to employ new learning strategies. The at-risk students in this study were not just passive learners, but active consumers of

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information. Concept mapping allowed all experimental students, but specifically the at-risk students, the opportunity to cast and then recast their own knowledge structure in a diagrammatic form. As a result of concept mapping, the gains in at-risk students' achievement levels were substantial.

The technology teachers involved in this study during post interviews felt strongly that concept mapping's visual component helped at-risk students. They felt that the lecture, labs, and concept mapping did have a significant effect on levels of achievement. The results of this study suggested that concept mapping works for at-risk students, and should be considered along with other effective teaching methods in technology programs.

In the Appendices, there are a series of concept maps developed by students participating in this study. An inspection of the student's concept maps revealed the relationships between concepts and new ideas. Appendix E contains a concept map constructed by students. The first map (A) depicts the combination of all four instructional units of study. The structure and style fit the expressed format for a good concept map. The most general expression is the word computer, linked by prepositions, and as the student moves down the levels, one can see more specific concepts along with cross linkage.

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The second concept map (B) depicts the unit of study on the microprocessor. The concept map starts with a general concept linked with prepositions. This map may have worked for this student, but to an outsider, there would appear to be serious information gaps. It did not fit the expressed format for a good concept map. Because there was no absolutely correct or incorrect map, a review of this instructional unit suggested that this student may have had prior knowledge of computers, and developed a map tailored to himself or herself.

The third concept map (C) was developed on the instructional unit microprocessors. This student substituted several personal words into his or her map. The student's map substitutes the word brain for the microprocessor chip. Apparently, the student had associated the microprocessor in a computer with the workings of a human brain. If this aided in the understanding of complex data, then the process of concept mapping worked. According to teachers who taught the classes, no student found concept mapping to be less than "something helpful."

However, in order to promote concept mapping in the junior high school technology classroom as a practical learning strategy, it must appeal to teachers and administrators, as well as to students. The concept mapping

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strategy can be taught effectively to junior high or middle school teachers during district curriculum days. Also, the students' training program can consist of as little as two forty-minute training sessions as in this study. Students will improve their skills as they are exposed to more concept mapping exercises. The small number of training sessions required should also make the concept mapping strategy attractive to teachers.

The concept mapping learning strategy can be implemented with the most basic materials: pencil, paper, and a short teacher training program. Concept mapping will appeal to budget-conscious, yet educationally minded, school officials.

The participating teachers felt that students saw concept mapping as a tool to develop a means to solve problems. The ability of students to solve problems is very important for our nation's future. For all students, but specifically at-risk students, to be competitive in the future, they must be able to assemble, interpret information, and formulate ideas effectively. Concept mapping aided in this by enabling these students to look for, and make connections among pieces of information that otherwise appeared unconnected. This, in turn, will transfer into an increase in the efficiency of our public investment in schooling.

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Summary

The major purpose of this research was to determine the effect of the teaching strategy of concept mapping upon the acquisition of selected advanced technology concepts by at-risk students.

This research study provided empirical data on how at-risk students learned advanced technology concepts. Before this study, few data existed to describe the performance of at-risk students in technology courses. A review of the literature showed that much research had been done with student populations in college and high school settings. Many of these studies showed that concept mapping was successful with those student populations. This study investigated the viability of the use of concept mapping in technology classes at the junior high school level.

The overall finding of this research showed that concept mapping improved learning in at-risk students. The main finding of the study was that concept mapping benefited the at-risk students. Such benefits were not significant for the not at-risk students.

Conclusions

The findings of this study provided support for the following

conclusions:

1. The results of this study indicated that concept mapping improved

achievement levels for at-risk junior high school technology students. This

conclusion is based on findings as previously discussed that supported the

instructional strategy of concept mapping during and after instruction that led

to greater achievement as measured by the posttest.

2. The concept mapping technique was easy for at-risk students to learn

alone with their hands-on activities. This was supported during the post study

interviews with the technology teachers, who expressed their surprise at the

ease in teaching concept mapping. More importantly, the at-risk students

were easily able to develop and use their concept maps.

3. Learning occurred as a result of taking the pretest and the subsequent

posttest. As can be seen from figure 5 all groups improved from pretest to

posttest, but only the at-risk experimental group improved significantly.

Recommendation for Further Research

Overall, the results of this research were limited to the student population covered and the instructional methods used. The finding that at-risk students achieved significantly higher using concept mapping than did the not at-risk students has potentially significant ramifications for the education of at-risk students. Continued investigation into this area is both warranted and needed. Based on the conclusions of this study, the researcher would make the following recommendations regarding future research:

1. It is recommended that research examine whether students gain as much from concept maps provided by instructor as they do from generating their own concept maps.

2. The treatment should be extended beyond the six week period. Because of the closeness of the pretest and posttest, caution is urged in using this data as presented. It is recommended that similar studies be conducted in order to support this study's findings, that concept mapping, in itself, triggered improvement in at-risk students.

3. It would be useful to conduct a longitudinal study to determine the

effect of concept mapping, beginning at the grade level at which technology education as a content subject is introduced.

4. Because the pretest and posttest were two dimensional in nature--that, is pencil and paper--computer-based three-dimensional concept mapping program should be conducted.

5. Additional research should ascertain the relationships between concept mapping and the hands-on experiences provided in technology classes.

6. Concept mapping studies should be conducted at various grade levels in order to determine if concept mapping as a learning strategy is more effective at certain grade levels.

7. It is recommended that research be conducted to analyze student's responses to essay-type questions following the use of concept mapping strategy programs.

8. Further investigations are necessary to determine what effect concept mapping has by school, economic levels, and race.

Results supported the importance and power of concept mapping as a technique for moving at-risk students toward meaningful learning. Concept mapping as instructional strategy proved effective. Mapping as a curricular

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and teaching tool was also successful for the at-risk students. How students

learn advanced industrial technologies is an important topic. This study of

learning styles and strategies can improve advanced industrial technology

comprehension among students labeled at-risk. This study has produced

results that individuals involved in the process of educating our nation's

children can find useful. In addition, the levels of authentic achievement of the

at-risk students will enable educators to make knowledgeable decisions about

instruction in technology education.

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Appendix A

Learning Unit Activities

Unit Activities

Advanced Technology Concepts

Computers

Unit Description:

This course of study will introduce advanced technology concepts as they relate to the computer. The unit of study will cover the internal and external workings of a computer system. These units of study will cover the architecture, software, peripherals, hardware, and diagnostic tools used in the process.

Course Objectives:

As a result of their learning in this unit, students will be able to do the following:

1. Identify different computer systems.

2. Demonstrate safe working practices.

3. Read and analyze technical publications.

4. Use high-tech equipment.

5. Identify and categorize various types of computer functions.

6. Read and set up computer functions.

7. Identify possible malfunctions.

UNIT # 1
HARDWARE EXTERNAL

UNIT OBJECTIVES

When you have completed this unit, you will be able to do the following:

1.   Discuss the various parts of the computer system: motherboard, power supply, RAM, ROM, memory, disk drives, hard drives, tape drives, ports, serial/parallel ports, and keyboards.

2.   Demonstrate the application of the various parts of a computer system.

3.   Given the external parts, be able to discuss the functions of external parts as they relate to each other.

4.   Be able to discuss the new hardware equipment on market.

Unit Activities

1.   Lecture on and discuss the different parts of a computer system.

2.   Develop a list of parts associated with computers.

3.   List the differences as related to parts of a computer system.

4.   Lecture on and discuss the different disk drives of the computer used in class.

5.   Demonstrate the assembling of a computer from its parts.

Experiments

1.   Students will assemble a computer system from parts.

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Concept Map

1. Students will develop a concept map from information learned from unit (experimental group only).

UNIT # 2

SOFTWARE

UNIT OBJECTIVES

When you have completed this unit, you will be able to do the following:

1.   Explain the difference between lower level language and higher level language.

2.   Discuss the symbols used in flow charting.

3.   Develop a flow chart that illustrates a step-by-step procedure for solving computer problems.

4.   Demonstrate programs using basic and pascal.

Unit Activities

1.   Lecture on and discussion of different software packages.

2.   Demonstration of the different software packages.

3.   Lecture on and discuss the different symbols associated with software programming.

4.   Demonstrate the development of a typical flow chart.

Experiment

1.   Students will write a flow chart program.

2.   Students will develop a flow chart using computer symbols.

Concept Map

Students will develop a concept map using the software concepts (experimental group only).

UNIT # 3

Peripherals

When you complete this unit, you will have the following knowledge and capabilities:

1.   Given a computer system, you will be able to identify at least six additional peripheral devices: modems, printers, C-D roms, joystick, light pen, scanner, mouse.

Unit Activities

1.   Lecture and identify additional devices used with computer   devices.

2.   Lecture and discuss the basic operations of peripheral devices.

3.   Demonstrate the different operations of the various peripheral devices.

4.   List and describe the various new peripheral devices on the markets.

Experiments

1.   Students will identify the different parts of the printer system.

2.   Students will identify the various peripherals such as C-D rom, scanners, joysticks.

Concept map

1.   Students will develop a concept map linking peripherals with the computer system (experimental group only).

UNIT # 4

HARDWARE INTERNAL

UNIT OBJECTIVES

When you have completed this unit, you will be able to do the following:

1. Define the terms microprocessor, microcomputer, input, output, instructions, word, byte, memory, address, read, write, ram, rom, and bus.

2. Discuss the purpose of a typical microprocessor.

Unit Activities

1. Lecture/slides on the history of computers.

2. Lecture on and demonstration of internal working of a microprocessor.

3. Lecture about and demonstration of the different types of microprocessors.

4. Draw a bus diagram and trace information flow through a microprocessor.

Experiments

1. Draw a computer diagram that shows the internal organization of a computer system.

Concept Map

Draw a concept map to show the logical organization of a microprocessor (experimental group only).

APPENDIX B

Gil-Tech I

Gil-Tech I

Please answer all questions.

True or False

_____ 1.   All seventh and eighth grade students need to know how to use

a computer system.

_____ 2.   A person playing on an electronic game system is using a

computer system.

_____ 3.   A person playing a computer game knows how to use a

computer.

_____ 4.   A computer is a keyboard and a television.

_____ 5.   The most common method of entering information into a

computer system is by a keyboard.

_____ 6.   The main purpose of a computer system for kids is to enable

kids to play computer games.

_____ 7.   The computer system has three major parts which are

input/output, microprocessor, and storage system.

_____ 8.   Most of the information that one types into a computer system

will be stored in the television.

_____ 9. A byte of information in a computer system is 8 bits of data.

_____ 10. Most new computer systems usually have hard drives already installed in them.

_____ 11. The term D.O.S. means disk organized system.

_____ 12. Computers function better than humans in some cases.

_____ 13. When you enter a keyboard program into a computer system you are using a software package called "basic."

_____ 14. All computers use a standard wall outlet electricity which is 120 volts A.C., and not the 5 volts D.C.

_____ 15. A flow chart shows a logical flow of a computer program.

_____ 16. When one writes a program in basic and enters it into the microprocessor it is saved in the monitor.

PLEASE ANSWER ALL QUESTIONS

Multiple choice

_____ 17. When a person begins to use a computer, he/she must turn on what kind of power source?

      A. Alternating current (A.C.)

      B. In-line power

      C. Direct current (D.C.)

D.   Power on line

_____ 18.   A commonly used brand name computer system used in many

schools is?   .

A.   Apple

B.   Clone

C.   New Edge

D.   Nintendo

_____ 19.   The major parts of a computer system are...

A.   ROM,RAM,and Floppy disk

B.   Input/output, Microprocessor, and storage

C.   Keyboard, Disk drive, and Monitor

D.   Input, Process, and output

_____ 20.   The human brain is to the human body as the _____ is to a

computer system.

A.   Keyboard

B.   Microprocessor

C.   Bus System

D.   Disk Drive

_____ 21.   All information entering a computer system travels in or out of

the microprocessor riding through the...

    A.   Memory Lines

    B.   Diskette

    C.   Bus System

    D.   Electrical power

_____ 22.   The figure below is an example of a...

    A.   Timing Chart

    B.   Flow chart

C.   Block Diagram

D.   Graph

_____ 23.   If you were a computer programmer you could be writing a

program using...

A.   Basic

B.   Pascal

C.   Cobol

D.   All of the above

_____ 24.   Most computers having a 3.5" disk drive will   usually have...

A.   360 K diskette

B.   1.2 meg. diskette

C.   1.4 meg. diskette

D.   512 K diskette

_____ 25.   The most commonly used output device that will give you a

paper copy is a...

A.   Monitor

B.   Modem

C.   Printer

D.   C-D rom

_____ 26. The two most commonly used computer keyboards are...

    A. Standard (XT) or Enhanced (AT)

    B. Standard (XT) or Unique

    C. Enhanced (AT) or Voice

    D. Epsom keypad

_____ 27. The computer programming symbol below is ...
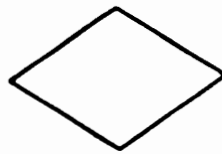
    A. Decision

    B. End

    C. Start

    D. Go to

_____ 28. The values 80486, 80386, 80286, and 6502 are

    A. Computer model numbers

    B. Microprocessor types

    C. The average cost of a computer

    D. Cost of computers

_____ 29. Most computers use diskettes that are 5 1/4" or...

    A. 3 1/2"

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B.	5 1/4"

C.	3 1/4"

D.	8 3/4"

_____	30.	A computer system's joystick is used as an...

A.	Output device

B.	Input device

C.	Second keyboard

D.	Controller

_____	31.	The microprocessor is controlled by a software program that

uses...

A.	An instruction set

B.	Address locations

C.	A processor board

D.	Disk drives

_____	32.	A computer system's printer plugs into a/an...

A.	External switch

B.	Serial or parallel port

C.	A.C. outlet

D.	D.C. plug

_____ 33.   The word <u>binary</u> means...

        A. One

        B. Two

        C. Three

        D. Four

_____ 34.   C-D rom diskettes are...

        A. Hardware

        B. Software

        C. Programs

        D. Output ports

_____ 35.   The microprocessor and memory chips are on a board called

a.....

        A. Mainboard

        B. Motherboard

        C. Control board

        D. Input board

APPENDIX C

Gil-Tech II

Gil-Tech II

Please answer all questions.

True or False

_____ 1. A person playing on an electronic game system is using a computer system.

_____ 2. The computer system has three major parts which are input/output, microprocessor, and storage system.

_____ 3. Most of the information that one types into a computer system will be stored in the television.

_____ 4. Most new computer systems have hard drives already installed in them.

_____ 5. The term D.O.S. means disk organized system.

_____ 6. When you enter a keyboard program into a computer system

you are using a software package called "basic."

_____ 7. All computers use a standard wall outlet electricity which is 120

volts A.C., and not the 5 volts D.C.

_____ 8. A flow chart shows a logical flow of a computer program.

_____ 9. When one writes a program in basic and enters it into the

microprocessor it is saved in the monitor.

PLEASE ANSWER ALL QUESTIONS

Multiple choice

_____ 10.   When a person begins to use a computer, he/she must turn on

what kind of power source...

        A.   Alternating current (A.C.)

        B.   In-line power

C.   Direct current (D.C.)

E.   Power on line

____ 11.   A commonly used brand name computer system used in many

schools is...

A.   Apple

B.   Clone

C.   New Edge

D.   Nintendo

____ 12.   The major parts of a computer system are...

A.   ROM, RAM, and Floppy disk

B.   Input/output, Microprocessor, and storage

C.   Keyboard, Disk drive, and Monitors

D.   Input, Process, and output

____ 13.   The human brain is to the human body as the...is to a computer

system.

A. Keyboard

B. Microprocessor

C. Bus System

D. Disk Drive

_____ 14. All information entering a computer system travels in or out of

the microprocessor riding on the...

A. Memory Lines

B. Diskette

C. Bus System

D. Electrical power

_____ 15. The figure below is an example of...
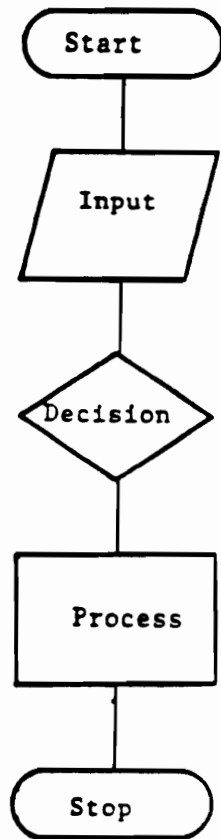
A. Timing Chart

B. Flow Chart

C. Block Diagram

D. Graph

_____ 16. The most commonly used output device that will give you a

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paper copy is...

A. Monitor

B. Modem

C. Printer

D. C-D rom

17. The two most commonly used computer keyboards are...

A. Standard (XT) or Enhanced (AT)

B. Standard (XT) or Unique

C. Enhanced (AT) or Voice

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_____ 18. The computer programming symbol below is...
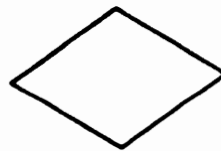
A. Decision

B. End

C. Start

D. Go to

_____ 19.   The numbers values 80486, 80386, 80286, and 6502 are...

    A.   Computer model numbers

    B.   Microprocessor types

    C.   The average cost of a computer

    D.   Cost of computers

_____ 20.   Most computers use diskettes that are 5 1/4" or...

    A.   3 1/2"

    B.   5 1/4"

    C.   3 1/4"

    D.   8 3/4"

_____ 21.   A computer system's joystick is used as an...

    A.   Output device

    B.   Input device

    C.   Second keyboard

    D.   Controller

_____ 22.   The microprocessor is controlled by a software program that

uses...

    A.   An instruction set

    B.   Address locations

    C.   A processor board

    D.   Disk drives

_____ 23.   The word <u>binary</u> means...

    A.   One

    B.   Two

    C.   Three

    D.   Four

_____ 24.   C-D rom diskettes are...

    A.   Hardware

    B.   Software

    C.   Programs

D.   Output ports

_____ 25.   The microprocessor and memory chips are on a board called

a...

A.   Mainboard

B.   Motherboard

C.   Control board

D.   Input board

APPENDIX D

Advanced Technology Class Schedule

Advanced Technology Class Schedule for both

the Experimental and Control Groups

Below is the schedule which will be implemented in the experimental

and control advanced technology concepts classes for this investigation.

<u>Day 1</u>   40 minute period classes

Minutes

  20 - Introduction to study.
  05 - Review of goals.
  10 - Review of objectives.
  05 - Summary of study.

<u>Day 2</u>

Minutes

  40 - Administration of instrument.

<u>Day 3</u>

Minutes   Hardware (external)

  10 - Introduction to computers.
  10 - Lecture and discussion on the computer system.
  10 - Review the different brands and features of the
   various computers.
  10 - Introduce concept mapping to experimental group.
      Review time for control group.

<u>Day 4</u>

Minutes

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40 - Review concept mapping with experimental groups.
Control group will use computers in class.

Day 5

Minutes

05 - Review parts of computer systems.
25 - Demonstration on the maintenance and care of computer parts.
10 - Concept map (Experimental groups).
Review materials (Control groups).

Day 6

Minutes

05 - Review parts of computer systems.
25 - Demonstration on the maintenance and care of computer parts.
10 - Concept map (Experimental groups).
Review materials (Control groups).

Day 7

Minutes

05 - Review yesterday's lesson.
05 - Lecture and discuss the different types of power used by computers.
10 - Lecture and discuss the different types of monitors.
10 - Demonstrate the different monitors.
10 - Concept map (Experimental groups).
Review lesson (Control groups).

Day 8

Minutes

  10 - Review lesson.
  30 - Students will work on computer systems.

Day 9

Minutes

  10 - Review materials.
  30 - The experimental group of students will construct a
       concept map dealing with computers (external).
       The control group of students will review the
       computer (external) unit by lecture and discussion.

Day 10   Software

Minutes

  10 - Introduction to software.
  20 - Lecture and discuss the D.O.S. software.
  10 - Concept map (Experimental groups).
       Review lessons (Control groups).

Day 11

Minutes

  05 - Review lesson.
  25 - Demonstrate several software packages.
  10 - Concept map (experimental group).
       Review lesson (Control group).

Day 12

Minutes

05 - Review lesson.
20 - Lecture and discussion on programing.
15 - Demonstrate a sample program written in "basic".

Day 13

Minutes

05 - Review lesson.
35 - Lab where students will use computers.

Day 14

Minutes

05 - Introduction to the numbering system.
25 - Lecture and discuss the different numbering systems used by computers (Binary, base ten, base eight, base sixteen).
10 - Concept map (Experimental groups).
        Review lesson (Control groups).

Day 15

Minutes

10 - Review lesson.
30 - Worksheet (numbering systems).

Day 16

Minutes

40 - Experimental groups of students will draw a complete
     concept map.
     Control group of students will review the software
     unit.

<u>Day 17</u>   Hardware (Internal)

Minutes

05 - Introduction to computer hardware (internal).
25 - Lecture and discuss the various internal parts of the
   computer: power supply, microprocessor, motherboard, ram,
rom, and disk drives.
10 - Concept map (Experimental groups).
     Review lesson (Control groups).

<u>Day 18</u>

Minutes

05 - Review material.
35 - Demonstrate the assembling of a computer.

<u>Day 19</u>

Minutes

05 - Review material.
35 - Students will assemble the computer systems.

<u>Day 20</u>

Minutes

30 - Students will continue to assemble the computers.
10 - Concept map (Experimental groups).

Review lesson (Control group).

<u>Day 21</u>

Minutes

05 - Review lesson.
30 - Lecture and discuss the different microprocessors:
   8080, 80286, 80386, 6502, 6800, 68,000, and Z80.
05 - Students will inspect microprocessors chip.

<u>Day 22</u>

Minutes

05 - Review lesson.
35 - Open lab for computer use.

<u>Day 23</u>

Minutes

05 - Review lesson.
35 - Students will work on computers.

<u>Day 24</u>

Minutes

05 - Review materials in unit.
35 - Experimental groups of students will construct full concept
   maps.
   Control groups of students will review unit materials through
   lecture and discussion.

<u>Day 25</u>   Peripherals

Minutes

  10 - Introduction to peripheral devices.
  25 - Lecture and discuss several peripheral devices: c-d rom,
       modem, printers, joystick, and mouse.
  10 - Concept map (Experiential groups).
       Review lesson (Control groups).

<u>Day 26</u>

Minutes

  05 - Review lesson.
  35 - Demonstrate the printer, c-d roms, and mouse
       operations.

<u>Day 27</u>

Minutes

  05 - Review lesson.
  35 - Students will work on complete computers system using the
    printer.

<u>Day 28</u>

Minutes

  05 - Review lesson.
  35 - Students will use the computer system and c-d rom.

<u>Day 29</u>

Minutes

05 - Review lesson.
35 - Students in the experimental groups will construct a complete concept map dealing with peripherals.
Students in the control group will review the unit dealing with peripherals.

Day 30

Minutes

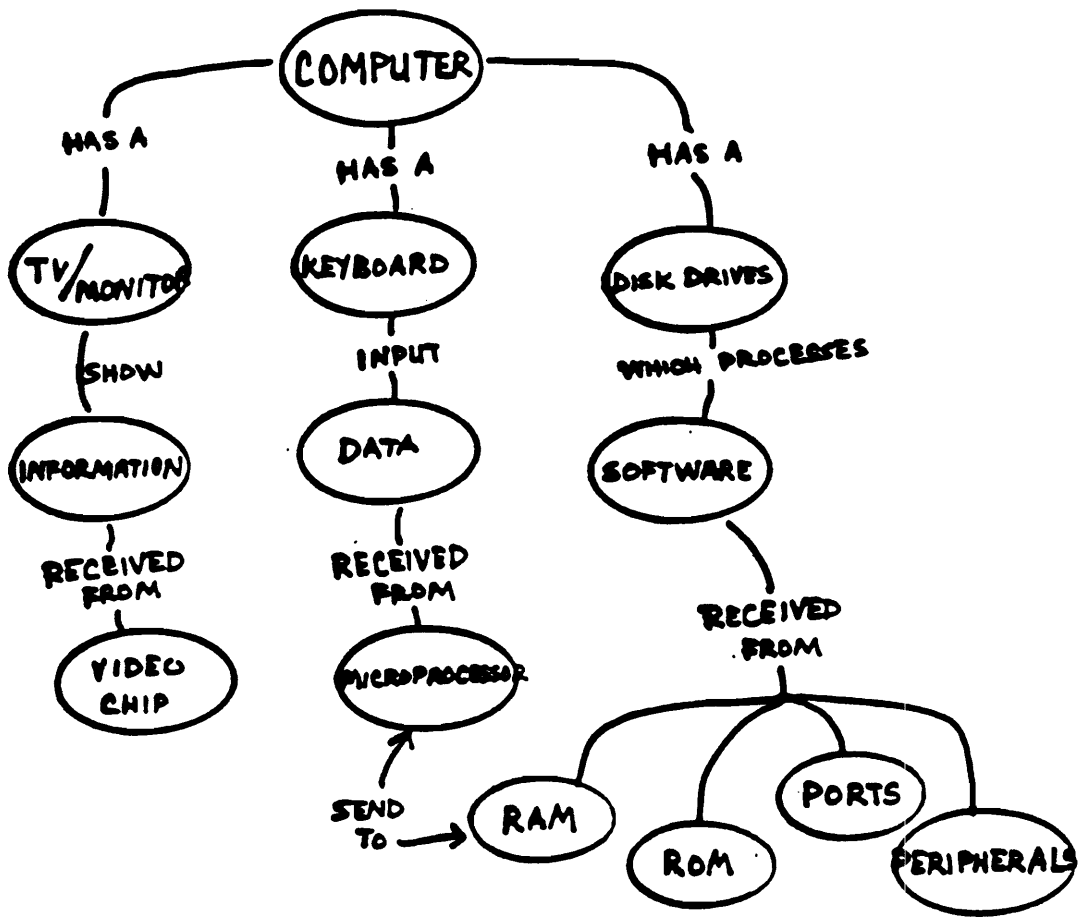40 - Review all units of study with both the control and experimental groups.
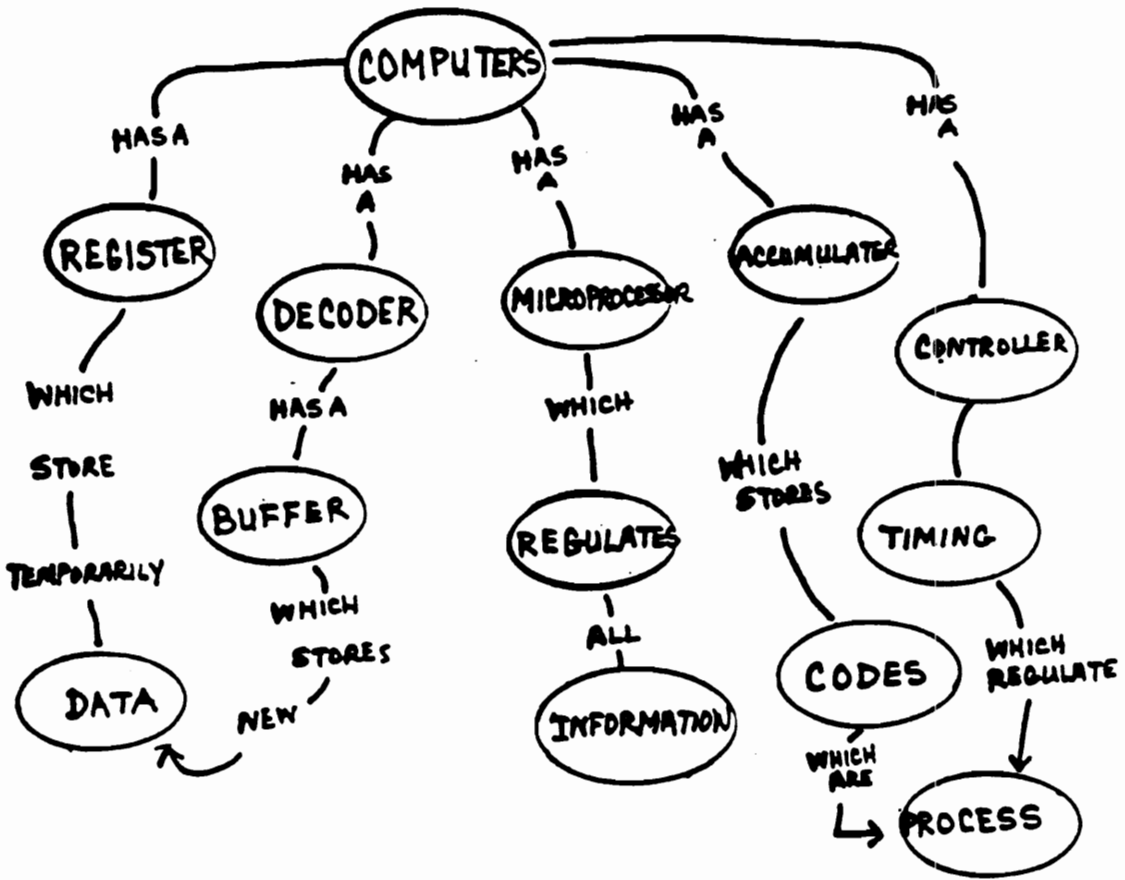
Day 31

Minutes

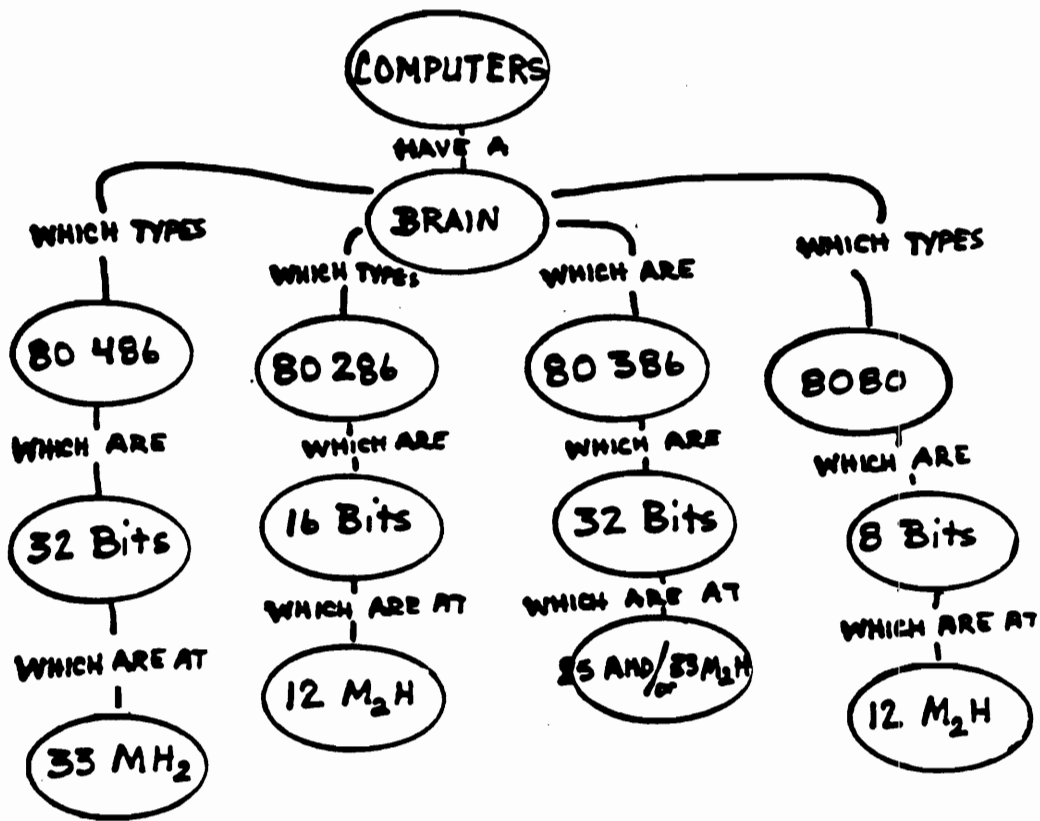40 - Administration of instrument # 2 posttest.

APPENDIX E

Concept Map

Concept Map A

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Concept Map   B

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                    ┌─────────────┐
                    │  COMPUTERS  │
                    └─────────────┘
                       HAVE A
                    ┌─────────┐
                    │  BRAIN  │
                    └─────────┘

WHICH TYPES      WHICH TYPES      WHICH ARE      WHICH TYPES

 ┌────────┐      ┌────────┐      ┌────────┐      ┌────────┐
 │ 80 486 │      │ 80 286 │      │ 80 386 │      │  8080  │
 └────────┘      └────────┘      └────────┘      └────────┘

 WHICH ARE       WHICH ARE       WHICH ARE       WHICH ARE

 ┌────────┐      ┌────────┐      ┌────────┐      ┌────────┐
 │ 32 Bits│      │ 16 Bits│      │ 32 Bits│      │ 8 Bits │
 └────────┘      └────────┘      └────────┘      └────────┘

WHICH ARE AT    WHICH ARE AT    WHICH ARE AT    WHICH ARE AT

 ┌────────┐      ┌────────┐      ┌──────────┐    ┌────────┐
 │ 33 MH₂ │      │ 12 M₂H │      │25 AND/83M₂H│  │ 12 M₂H │
 └────────┘      └────────┘      └──────────┘    └────────┘
```

Concept Map   C

VITA

VITA

The author was born on September 30, 1951 in Chicago, Illinois as the eldest boy of four children of William and Katie Gilchrist. He attended Parkman Elementary School. He graduated from Dusable High School in 1969. During the Fall of 1969, he enrolled in Eastern Illinois University, where in 1972 he received a B.S. degree in education with a major in Industrial Technology. He continued at Eastern Illinois University and completed a master's degree in 1973, in school administration. In 1981, he graduated from National Lewis University with a Certificate of Advanced Study, with a major in special education administration.

After the author graduated, he became a faculty member teaching technology education in several junior and senior high school districts. The author is presently a department chairman in Evanston's school district located in Illinois, where he supervises the technology programs. He also teaches technology courses in the local college system.

The author is a member of the International Technology Education Association (ITEA), Phi Delta Kappa, and Illinois Electronic Educators Association. He has been a consultant to primary and secondary schools

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systems relating to technology education curriculums.

The author is married to Janice Spivey Gilchrist. They have two children, Ronke and William.