COMPUTERS IN THE PRESCHOOL: A STUDY OF PIAGETIAN CONCEPTS, LOGO, AND C.A.I.

by
Shelley Delano Turnbull

A thesis
submitted in partial fulfillment
of the requirements for the degree of
Master of Education in the Department of Educational Psychology
The University of Manitoba
April 1985

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ABSTRACT

A review of previously conducted research indicates a large number of studies focussing on the general effects the Logo computer language has on young children. Very little of this research examines the effects Logo has on preschool children's cognitive development. Using both quantitative and qualitative research measures, this study examined the effect Logo and C.A.I. had on preschool children's ability to decenter. It was concluded that the Logo languge did not have a statistically significant effect in respect to the C.A.I. group on the Piagetian concept of decentering. The observations obtained supported past research regarding social and peer interactions and peer teaching. It is recommended that further research into the effects Logo has on young children's cognitive development be carried out on a longitudinal basis using both quantitative and qualitative measures.

Acknowledgements

I wish to thank my thesis committee, Dr. L. Sandals, Dr. A. Garrod, Dr. J. Hughes, Dr. I. McIntire, and Dr. H. Williams for their guidance and support during this research. A special thanks is extended to my advisor, Dr. Lauran Sandals for his patience, assistance, and continual support.

Appreciation and thanks is also extended to Margaret Petrie for her invaluable help and support in the collection of my data, and to Kathy MacKenzie for her help in the typing and printing of this thesis as well as her constant friendship.

To my fellow graduate students, I offer my thanks for their confidence in my research. A special thanks is extended to Stephen for his continual support.

Lastly, my deepest appreciation is extended to the children who participated in this thesis research. Their enthusiasm and enjoyment made this project most worthwhile.

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CHAPTER ONE

Introduction

The use of a computer as an educational tool is rapidly increasing. This increase in use is directly related to the development of new and better computer languages and programs designed with students' cognitive needs in mind.

Since its introduction, the computer has been generally regarded by some as the panacea of programmed instruction and individual teaching concepts. On the other side of the coin, it is viewed by others as an indication of a possible downfall of teacher-based education. Negative remarks are frequently based on the loss of human contact and the question of who is controlling whom? Is the student controlling the computer or is it vice versa? However one regards this tool, it is acknowledged that computers do provide certain positive, functional purposes within the classroom. Individualized instruction and learner-paced lessons are often cited as the most common advantages.

A recent trend in many elementary and junior high school classrooms utilizing microcomputers as instructional aids is the use of Seymour Papert's innovative computer language "Logo". The premise behind the Logo language is that through its use children will be able to learn basic Euclidean geometrical concepts using a discovery learning approach. Papert describes the experience as being similar to learning French while living in France (Papert 1980). Logo immerses the learner in mathematics just as living in France immerses the learner in French.

This total immersion theory directly relates to Piaget's theory of cognitive development. Piaget's theory heavily stresses the development of logical thought processes through interaction with the environment. According to Piaget, children's cognitive development is influenced by their environment and the materials present within it. The environment must support the preschool child's mode of learning, that being play. The nature of the play materials in the child's environment can effect his/her cognitive development. The materials must allow the child to manipulate and explore them. From these materials, the child will eventually assimilate, accommodate, and adapt to the ever enlarging environment.

Educators aware of Piaget's developmental theory realize the importance of an environment rich in learning materials. Computers, used in conjunction with pedagogically sound educational software can contribute to that environment. A drawback to this situation is often the cost factor of relevant software packages for young children. Papert, heavily influenced by Piaget's theory, dismisses the cost factor involved in computer related educational packages and instead offers Logo as the solution for software selection .

Papert's rationale for such a dismissal is based on his theory that Logo creates the ideal learning conditions for children by allowing them to relate to and interact with a cybernetic 'turtle'. The 'turtle' is accepted by the children in the same manner as a new toy would be. Its presenting appearance is nonthreatening and is devoid of stereotypical gender characteristics. The children are able to explore and accept it as part of their environment just as they would interact with any material already present in the classroom.

Much of the research available on the use of Logo presents data supporting the positive social effects the language has on the students who use it. This research does not directly address the claims made by Papert regarding the acquisition of higher level cognitive skills by children who use it. Papert's supposition that Logo will provide an environment that will facilitate cognitive growth through the acquisition of Euclidean geometrical concepts (Papert 1980) is largely untested in the preschool classroom.

Purpose

It is the purpose of this thesis to compare the effects of the Logo language with C.A.I. on young children's ability to decenter.

Statement of the Problem

A review of the literature indicates a dearth of research examining Logo in the manner that was set forth by Papert. The majority of the studies suggest that Logo facilitates social growth but does not address the question of whether the language helps children attain higher cognitive skills.

In order to maximize the strength of data obtained and to minimize the limitations of a single research method, a combination of qualitative and quantitative measures have been used in this study. As Eisner (1977) states, "Using qualitative and quantitative methods together provides a depth of perception, or binocular vision, that neither one can provide alone."

Derived from the stated problem is the following research hypothesis:

Research Hypothesis

Use of the computer language Logo is more effective in developing the ability to decenter than is C.A.I.

Definition of terms

Preschool children- Children who are within the range of 30 to 60 months of age.

C.A.I.-Computer assisted instruction.

Decenter- The ability to think simultaneously in terms of the whole and its parts (Ginsburg & Opper 1969, p.127).

Donaldson (1978) has defined decentration as the ability to move freely from one point of view to another, either in the literal or the metaphorical sense (Donaldson 1978, p.152).

Logo- The interactive computer language developed by Papert and described in his book Mindstorms (Papert 1980).

Learning-The acquisition of new concepts by children.

It is the intent of this study to examine the Logo language and young children's cognitive growth. Attention will be given to the following questions:

1) Can young children comfortably work within a computer environment?

2) Can young children 'learn' from C.A.I. programs?

3) Can young children 'learn' from the language Logo?

4) If young children can 'learn' from Logo, can their 'learning' be measured?

Factors that had to be considered when conducting this research were:

1) How could computers be introduced to preschool students as a part of their environment.

2) How could computer assisted instruction programs be introduced to

preschool students.

3) How could the computer language Logo be introduced to preschool students in both the abstract and concrete forms. The abstract form of Logo refers to the screen turtle version of the language where the turtle is visually displayed only while the concrete form refers to the robot turtle version which can be touched and physically manipulated.

4) How could preschool students be provided with an environment in which they could play with the computers as with any other toy .

5) How could preschool students be provided with the opportunity to explore the computer equipment and programs using a discovery approach.

CHAPTER TWO

C.A.I. and its Relation to Learning Theory

One of the major changes in the field of learning theory has been the shift from a behavioral to cognitive perspective (Gagne', 1982). This shift in psychological perspective has altered in the approach taken in the use of computers in education and computer assisted instruction. Following will be a review of the effect behavioral and cognitive learning theories have had on the use of computers in education. Both of these theories will be discussed in relation to computers in education and the development of instructional software for the classroom.

Historical Overview

Walker (1983) states "...one of the most consistent findings of educational research is that learning of all kinds is enhanced when learners can do something with what they are learning and see the results of what they have done" (p.103). If one considers this statement in relation to the historical development of computers in education, one can see how the philosophies and theories behind computer based learning have changed.

Influences of Behavioral Psychology

C.A.I. or computer assisted instruction has its roots firmly planted in behavioral learning principles. During the time the potential of computers in education was being recognized by educators,(the 1950's), the behavioral movement was enjoying immense popularity in psychology in North America

(Burke 1982).

The basis of behavioral psychology is found in E.L. Thorndike's connectionism theory and more explicitly, Thorndike's law of exercise and law of effect. Thorndike (1931) defines a connection as "...a name for the probability of a certain response occurring very soon after a certain situation;..."(p.18). He used this as the basis for his connectionism theory and from this derived two underlying laws, the law of effect and the law of exercise.

> ...the law of exercise or use or frequency, asserts that, other things being equal, the oftener a situation connects with or evokes or leads to or is followed by a certain response, the stronger becomes the tendency for it to do so in the future...the law of effect, asserts that what happens as an effect or consequence or accompaniment or close sequel to a situation-response, works back upon the connection to strengthen or weaken it (pp.6).

Thorndike's law of effect was originally used to test animal responses to certain stimuli. From this evolved the S-R (stimulus-response) theory which states "By reinforcing the animal for making the correct response (or successively closer approximations of it), the probability of the correct response occurring again in the presence of the stimulus is increased" (Burke,1982).

The relationship of Thorndike's S-R Theory to C.A.I. was later formed by the behaviorist psychologist B.F. Skinner. Using behavioristic principles and relating them to human learning, Skinner proposed that human responses to specific stimuli could be brought about in much the same way as animal responses. Using both human and animal subjects, Skinner concluded that the learning process was essentially the same regardless of the species being studied

(Skinner, 1968).

Skinner's ensuing interpretation of teaching was heavily based on the S-R concept. He argued that the aim of the educator was to imprint within the student a supply of verbal responses which could be evoked upon presentation of specific stimuli. Skinner acknowledged that immediate positive reinforcement was necessary for optimal learning to occur and that within a normal classroom, immediate reinforcement for twenty to thirty students was impossible for a teacher to administer at the appropriate time. As well, in order for the students to obtain reinforcement, they must be successful in completing the required tasks. Therefore, the lesson must be presented in small enough parts in order to give the students a chance at success. It was also acknowledged that students learn at varying rates depending on their individual learning style. The learning situation had thus expanded to include not only immediate reinforcement and step-by-step lessons but also the adaptation of the lesson to the individual learning style of each student. Referring to these educational requirements, Skinner (1968) stated that teachers would need to use mechanical or electronic aids in order to control the learning situation (p.22).

An initial solution was to employ a teaching machine. Originally, the idea of a teaching machine was credited to S.L. Pressey in 1926. It was Pressey's intent to use such machines as testing devices and then advance them to the level of being utilized as teaching tools (Pressey 1926). Ultimately, the machine never did reach the height of acceptance within the schools as the teaching aid Pressey had envisioned. Nevertheless, a longstanding concept did evolve out of the teaching machine when Skinner began advocating the use of a similar machine in the 1950's. This concept was programmed instruction or P.I.

Programmed instruction consists of blocks of information being presented to the learner in a linear, frame by frame mode advancing from simple concepts to the more complex. Advancement is accomplished when the learner responds correctly to a presented question. The information and subsequent questions are put forth in such a fashion as to allow the student to achieve a correct response via utilizing subtle hints contained within the question. In this manner, the student progresses frame by frame in a linear fashion through the program going from simple to complex questions and achieving positive results throughout the procedure.

Burke (1982) identifies the main components of programmed instruction as:

1. Small steps
2. Active responding
3. Immediate feedback (p.23)

These steps are also found within a concept which Skinner refers to as shaping. The main principle behind shaping is that reinforcement produces learning. By reinforcing closer and closer approximations to a desired behavior, the learner will focus on emmitting responses which result in reinforcement and subsequently, in learning of the correct response. Looking closely at the concept of shaping, the main components of programmed instruction and the focal point of behavioral theory, Burke (1982) states that many computer assisted instruction (C.A.I.) designs are based wholly on the above mentioned points. Burke's (1982) assertions support in theory the work of Caldwell (1980) who devised a series of guidelines for the development of instructional materials using microcomputers as the medium of presentation. Emphasizing the gearing of instruction to the individual needs of the learner, Caldwell (1980) states "One of the most important factors inherent in programs delivered on computer based systems is their ability to adapt instruction to the individual needs of each learner."(p.7) From such a statement it could be inferred that the learner had determined his needs and controlled the program in such a way as to ensure that the needs were met. This would be one interpretation. However, Caldwell (1980) further relates that "The power of computer-based instruction resides in its ability to shape learner behavior toward learning outcomes in a way not possible with most other media."(p.10) This statement is in keeping with the intrinsic behavioristic principles found in most C.A.I. programs. A summary of general features suggested by Caldwell (1980) for incorporation into the design of instructional programs are as follows:

> 1) Learner control over the instructional sequence...
> This ability of learners to pace themselves provides a degree of individualization not present in purely linear programs.
> 2) A system should be totally individualized and offer highly adaptive and responsive learning environments...
> 3) Programs should be modularized and structured in coherent, hierarchical patterns...
> 4) All skills to be mastered should be carefully stated in performance objectives...
> 5) Progress should be measured in terms of mastery of performance objectives...
> 6) Strategies for diagnosis and prescription should be used...
> 7) Programs should be, where possible, multisensory in format. (pp.7-8)

Caldwell (1980) further emphasizes that interactive lessons are important strategies to be utilized for this mode of instruction. His concluding comments support the use of learner control over the instructional sequence and the opportunity for students to achieve mastery of a lesson via branching, diagnosis, and remediation.

Reviewing C.A.I. from this perspective it can be demonstrated how it leant itself so easily to behavioristic learning principles. Stimulus-response presentation format, individualized instruction, immediate reinforcement for each response, and the ease by which shaping takes place are all key components of the majority of C.A.I. programs.

Categories of C.A.I.

From a historical viewpoint, educators have commonly categorized C.A.I. programs into four categories; drill and practice, tutorial, simulation, and game. Hallworth and Brebner (1980) describe drill and practice as consisting of the presentation of a question or problem which the student answers and which is then immediately marked with reinforcement given for a correct answer. If the answer is incorrect, either hints for correction are given, the student tries the question again, or else a new question is given.

Drill and Practice

Jerman (1970), Fiorentino (1977), Wager (1982), Papert (1982), Fiske (1983), Sheingold, Kane and Endreweit (1983) and Ziajka (1983) all report that drill and practice is consistently used in basic skills areas such as math and reading or language arts. Essentially it focusses on the areas of education most commonly associated with the rote learning style. Hallworth and Brebner (1980) further elaborate on the description of drill and practice by saying that if the reinforcement or feedback part of the instruction were left out, the program being used could then be utilized as a testing instrument.

Gagne' (1982) reflects on the use of drill and practice as being essentially good for the learner if drill concepts are needed. Although such programs utilize behavioristic principles of stimulus-response, Gagne' (1982) states that certain skills inherent in higher ordered problem-solving abilities must be at the point of automatic response in order for the learner to be fully utilizing all cognitive abilities. "The important thing is that modern theory implies very strongly that certain kinds of basic skills not only need to be learned but AUTOMIZED" (p.14). Gagne' elaborates that this theory of automaticity has not yet been fully explored and he anticipates strong resistance from educators following an anti-behavioristic philosophy.

Tutorial

Tutorial C.A.I. programs as described by Wager (1982) consist of the presentation of information followed by questions on the content of that information. Immediate feedback is given for the student responses.

Jerman (1970) discusses the tutorial type C.A.I. program from the standpoint of being the most traditional or well-known type of computer presented instruction. Jerman (1970) then goes on to say "This concept, no doubt, is behind the often-heard question 'Will C.A.I. replace the classroom teacher?'" (p.54). Ziajka (1983) relates that tutorial type programs are currently being used by teachers for tutoring in areas of specific knowledge concepts such as science. Wager (1982) relates the tutorial mode of presentation to Gagne's model of learning based on cues and information retrieval. This theory of learning is referred to as the information processing model (Gagne' 1974).

Simulation

Simulation type programs are designed to allow the student to experience a real-life situation focussing on decision-making and problem solving without the actual consequences of the decisions ever occurring. Hallworth and Brebner (1980) describe simulations as being a learning experience in which a student acts through a situation and learns by seeing the results of the decisions he or she has made.

Bitter and Camuse (1984) interpret simulations as being an experiential situation which would be too difficult to reproduce in a classroom setting. The following is their description of a simulation:

> Simulations allow students to make, and be affected by, their own decisions. Guided according to the data provided by the simulations, the student selects certain options or risks, and then witnesses the results of the decision. (p. 49).

Students using the discovery method of learning in a simulation situation can often find the relationships between variables present in the program (Wager 1982). Grade nine students at St. Anne's School in Brooklyn Heights, New York, worked through the relationships between speed and mass using a simulation program in Einstein's Theory of Relativity. Students manipulate their weight and speed of travel in order to see the effects increases/decreases have on both variables (Fiske 1983).

Games

Game programs often fall into a category somewhere between drill and practice and simulation. Programs developed using a game approach often incorporate two concepts together. Relying on the competitive or quasi competitive nature of a student, many programs will imbed complex material or repetitive drill concepts in a 'beat the computer' or 'match your wits and/or skills against the computer or fellow student' format. In this way, the student is learning new material or reviewing concepts in a way that is exciting and fun. The computer then becomes more than an electronic page turner. Using color, graphics, and sound, the computer becomes a high level motivator and a stimulating teacher.

In a discussion of what computers could mean to education and how educators could take advantage of a computer's capacity for interactive instructional material, the Report of the Advisory Committee on Computers in Education, Manitoba Department of Education, (1982) stated that a variety of computer instructional presentations can enrich the learning situation by providing a form of interaction with the learner which is beyond what a teacher could reasonably be expected to provide (p.12). Teachers could not be expected to embedd boring or complex material in a game format on a daily basis but computer programs can. Burke (1982) summarizes a game design in the following;

> If the objectives of a C.A.I. lesson can be accomplished with a gamelike approach, the motivation of the students can sometimes benefit greatly. Games are often good for keeping up a rapid pace of learning and increasing the student's affective involvement in the lesson, thereby possibly increasing learning and retention. (p.94)

Bitter and Camuse (1984) refer to programs with problem situations in which concepts are not taught but instead refined through application as being "high-level, problem-solving programs..."(p.58). They further state that these programs could also be described as being "educational games" (p.59).

Summary of C.A.I.

The four major forms of CAI that have been described are drill and practice, tutorial, simulation and games. All were originally developed based on the concepts of behavioral psychology, which was the popular theory of learning at the time. However, other theories developed all over the world are constantly being accepted and in the late 1960's and early 1970's, a widely known and accepted European theory of learning based on the stages of cognitive development, became popular enough to challenge the behaviorist tradition of stimulus-response learning in North America. The theory of Jean Piaget is referred to as Piaget's Theory of Intellectual Development and was based on more than fifty years of direct observation, interviews and tests of children and their learning. This theory development was in direct contrast to the behavorial theorist Skinner, who had hardly studied children (Ginsburg & Opper, 1969).

Piagetian Theory of Cognitive Development

According to Ginsburg & Opper (1969), Piaget & Inhelder (1974), (1969), Beard (1972), Pulaski (1971), Piaget (1977) and Travers (1982), Piaget's theory views the development of intelligence as resulting from one's actions, not from one's language. In essence, an individual constantly strives for cognitive equilibrium with one's environment. However, the environment is continuously changing and thus constant equilibrium is not always possible. Therefore, through a process of assimilation and accommodation, adapatation to the changes occur resulting in a restored state of equilibrium. The organization of one's thoughts and actions to achieve adaptation and equilibrium results in the modification and creation of what Piaget calls structures. These structures take different forms at various ages throughout an individual's life and are referred to as organized patterns of behavior based on experiences and actions.

Piaget has divided his theory of intellectual development into four developmental stages which have general age guidelines for each stage. His premise is that each person passes through these stages in a hierarchical fashion building upon concepts developed in the previous stage. The stages can be summarized as follows:

1) Sensorimotor Stage- birth to two years. The child possess innate structures, one being the sucking reflex. The chief characteristic of this stage is the development from primary circular reactions (chance behaviors leading to habits) to tertiary circular reactions (the reproduction of an event to produce novel results).

2) Preoperational Stage- Two years to Five years. the main characteristic of a preoperational thinker is perception-bound thinking. In other words, the child is very concrete in his thoughts and actions. Terms such as egocentric, centered, irreversability, tranductive, all describe a preoperational child. It is also in this stage that the development of symbolic activity and language takes place.

3) Concrete Operations Stage- Five years to 11 years. In this stage, there is a general decline of egocentrism and an increase in language. True classification behavior emerges as well as the concept of reversability. Seriation and concept of number develops and from this (as well as from classification) develops the idea of conservation. This is one of the crucial points in the concrete operation stage of development.

4) Formal Operational Stage- Eleven Years to Adult. The concepts learned and developed in the former three stages lead to this last stage of development. In this stage, individuals develop abstract thought, hypothetic-deductive thinking, generalization of concepts, etc., and objectivity (Piaget & Inhelder (1969), (1974), Ginsburg & Opper (1969), Beard (1970), Piaget

(1971), Pulaski (1971), Renner et al (1976), and Travers (1982)).

Thus, Piagetian theory proposes that cognitive development proceeds from the concrete to the abstract with each stage of development depending upon prior stages. As well, environmental influences are crucial for intellectual development for it is through the individual's interactions with the environment that leads to cognitive growth. Therefore a child whose surroundings are rich in stimuli will be constantly striving to understand and adapt to the stimuli, thus nourishing his cognitive growth.

This theory of cognitive development contrasts with behavioristic theory. The cognitivists believe that an individual learns by acting upon the environment while the behaviorists assert that learning occurs due to environmental influences upon the individual. (Bigge, 1982).

CHAPTER THREE

Review of Related Literature

> During the past few years, the influx of microcomputers has grown from a mere trickle to a torrent, engulfing teachers and administrators in a flood of confused expectations and unfulfilled promises.
>
> Watt, 1983 p.83

The speed with which microcomputers have found their way into some classrooms is accurately reflected in the above statement. The preschool classroom is not an exception. Since the development of the Logo language in the late sixties by Papert and colleagues and its subsequent adaptation to the microcomputer, Early Childhood educators have been accepting it as the least intimidating of all computer related learning systems. From this, Logo has been adopted wholeheartedly as a means of introducing young children to computer environments. It is the purpose of this chapter to present the theory underlying the computer language Logo and review the recent research available on Logo regarding its application in Early Childhood education.

Papert's Theory of Logo.

A definition of Logo would be simply that Logo is an interactive computer language which provides a form of communication between a cybernetic or screen turtle and the user (Papert, 1980). As stated by Papert (1980, 1981, 1982, 1984), Nelson (1981), Overall et al (1981), Abelson (1982), Billstein (1982), diSessa and White (1982), Higginson (1982), Lawler (1982), Riordon (1982), Shapiro (1982), Solomon (1982), Tursman (1982), Upitis (1982), Watt (1982), Williams (1982), Bull and Tipps (1983-84), Hines (1983), Lough (1983), and Noss (1983),and Torgerson (1983-84) Logo is much more than a language. These researchers describe Logo as an environment where children and adults learn powerful ideas through exploration and mastery. However, before one can fully understand the Logo language, the development of Papert's theory must be examined.

A student of Piaget's in the early 1960's was a mathematician by the name of Seymour Papert. Papert, whose main interest was in the education of young children and the creation of the perfect learning environment was strongly influenced by Piaget's theory. This is evident by his continuous references to the learning environment and the statement: "I take from Jean Piaget a model of children as builders of their own intellectual structures" (Papert, 1980, p. 7). From this, Papert discusses how children learn and acquire knowledge through their own efforts, without formal instruction. A believer in surroundings rich in learning materials, Papert asserts that lack of environmental cues are responsible for the inability of children to grasp certain concepts as well as they should. This differs from Piaget's belief which states that the inability results because it is due to the complexity of the concepts to be learned. Focussing on the area of Euclidean geometry, Papert maintains that a child given materials natural to his/her environment will, through exploration and discovery, learn the basic concepts of said geometry. This is not to be interpreted as the child will know them in the formal sense of theorems and equations but rather will know them in a way that makes them meaningful and relevant to the child's way of functioning at that point in his life.

One of Papert's beliefs is that computer learning environments are powerful ways to help create the perfect learning situation. In order to achieve this, Papert has developed a language called Logo which utilizes both a screen cursor called a turtle and cybernetic robot also called a turtle. Papert (1980) refers to the turtle as an object-to-think-with and one that allows cross-cultural identity, embedded knowledge and personal identification (Papert, 1980, p. 11).

Through Piaget's teachings, Papert (1980) recognizes that play is an important method of learning which preschool children utilize constantly. Fein (1983) elaborates on Piaget's interpretation of play as being:

> Piaget's most important contribution to the idea of play as a window on thought and emotion comes from his view of play as assimilation (Fein, 1983).

In short, children must, through the processes of assimilation over accomodation, master whatever it is they are attempting to play with before sheer play for the pleasure of the activity can occur (Piaget, 1962). Papert therefore proposes that given a computerized learning environment using Logo, which children can explore, discover, and play with at their own rate, they will learn the basic properties of Euclidean geometry and problem solving in a way intrinsic to each child. Thus, the computer, with the Logo language, is envisioned as assumimg the role of facilitator within the child's environment.

Krasnor and Mitterer (1984) have written "The Logo experience was designed explicitly to facilitate the learning of powerful ideas, skills, and heuristics which transcend the immediate task environment and can be applied in other problem-solving areas"(p.133). The predominent viewpoint of Logo adopted by most researchers is summed up by Harvey's (1983) statement that "Logo is a language for learning" (p.163). From this, the power of Logo is generally regarded as being found in the theory of learning it advocates. This theory is based on the Piagetian theory of learning through exploration and discovery of one's environment resulting in mastery and adaptation of relevant concepts.

Papert (1980) observed that most forms of classroom learning are measured using a testing format of evaluation. With this type of measure, what a student learns is either right or wrong with no credit given for the underlying process of obtaining the resultant answer. In the Logo environment, what a student learns is relevant to what the student wants to know at that point in time and also, to what the student is capable of learning, independent of what levels of learning other students in the class are at. For Papert, who was a devout follower of Piaget and his theory, learning is a process oriented approach. Papert (1980) proposed that children could use a computer as "an object to think with" contingent upon it being accepted by them as a natural part of their learning environment such as a toy or play-object.

It is commonly agreed upon by Early Childhood educators that young children learn through play. Weininger (1979) has said:

> It is through play that the young child recreates the world and comes to understand it, his play is predicated on his experiences. Play is not aimless or purposeless or undirected. It is the child's attempt to achieve, to feel comfortable, and hence to be able to innovate and change his world (p.5).

Relating the concept of a technology oriented society to basic human values and how they can be meshed within a learning environment, Pluimer (1984) states "Understanding the computer is child's play compared to understanding child's play" (pp.16-17).

Anker, Foster, McLane, Sobel and Weissbourd (1974) propose that most educators are in agreement with the theory that free choice of activities and meaningful, environmental interaction are key components to young children's learning. Rossman (1983) connects the use of computers as machines to be programmed to the use of computers as a means of playing with programming concepts. From this respect, Rossman (1983) advocates the use of Logo as the language through which meaningful programming concepts can be acquired through play.

Logo Research Projects.

Of more than forty- eight research projects reviewed, it was found that only four projects implemented the Logo language using Papert's recommended approach, that being the play approach to learning. Studies were found where students were introduced to computers via the play approach or else were allowed to play with the computers in the preschool class but these did not involve the use of the Logo language.

One study reviewed (Rubens, Poole, Hoot, 1984) did advocate the use of play for allowing children to become accustomed to computers. It was found, however, that while the researchers advocated the use of play as the mode of learning, they only allowed the children access to cardboard replicas of computers.

The studies presented here were selected on the basis of their use of Logo within the classroom. All of them do not pertain to the preschool level of education. It was found that there is a definite lack of research on Logo in the preschool classroom in general. Research on Logo in conjunction with the play approach to learning is practically nonexistent.

A review of the literature on Logo reveals few settings using Papert's recommended play approach for the learning of the language. Many settings imposed a high degree of structure on the teaching of the language and then attempted to compare the research results with those found by Papert. The Chiltern Logo project (Noss, 1983) was designed to evaluate teaching strategies for implementing Logo in classrooms of eight to ten year old children. Although the aim of the project was to develop and propose teaching strategies, the investigator reported that initial attempts at structuring the instruction proved fruitless. Noss (1983) revealed that the children were not ready for formal instruction using Logo. The researchers had to allow the teachers to assume the role of facilitator and the children that of explorers. The children were better able to learn the language when they approached it in an unstructured manner.

A research project referred to as the Edinburgh Project (1980) used Logo as a means to enhance mathematical skills amongst 12 and 13 year old boys attending a private school in Scotland. During a two year period, students were taught Logo concepts via a series of graded worksheets and also completed special assigned Logo projects designed to enhance the regular math curriculum. The researchers conclude that mathematical understanding was enhanced in the students given Logo who also displayed a more positive attitude regarding mathematics as a whole. However, results on a basic maths test were not meaningful. The Logo group achieved only a slightly higher score than the control group.

Papert's (1980) claims that Logo can successfully create a transfer of learning effect with regards to problem-solving concepts, procedural planning strategies to achieve goals, and a more positive attitude towards errors (referred to as bugs) are so far untested. The previously cited studies, the Chiltern Logo Project and the Edinburgh Project, had both intended to test for specific skill attainments. The researchers acknowledged greater changes in attitudes, social skills and learning styles than changes in specific cognitive processes.

Play Approach Studies.

Another project, the Brookline Logo Project consisted of two research studies, one following from the other. The initial project was implemented by Papert's M.I.T. research group and the public schools of Brookline, Massachusetts (1979) in order to see if Logo was appropriate for students with different learning styles and needs. Using Papert's approach of the student as explorer and the teacher as facilitator, data on 16 students were obtained in the areas of student learning styles and in the amount of information obtained in the areas of computer programming and mathematics. The second part of the project focussed on the development of the curriculum supporting the classroom use of Logo.

Using grades four to eight students, curriculum materials were developed and placed within the classroom for assessment. The materials ranged from introductory how-to lessons to advanced Logo games utilizing a microworld and a dynaturtle. The games were designed to allow the students to be able to modify them according to their own needs. The results indicated students could use the games as steps in developing higher level programming concepts. More conclusively, data revealed a trend in which students with a good knowledge base of Logo concepts easily became teachers for their peers. A related trend was that of the development of high level social interaction among the students who worked on the Logo projects.

Supporting the results of the Brookline project is the ongoing Computers in the Schools research in New York city. Grades two through nine are given microcomputers and Logo with each class having access to them from within the classroom. Increases in student interaction, activity, and interest are credited to the use of Logo and the availability of the computers.

Focussing more directly on Papert's claims of what Logo can do, the Lamplighter Project in Dallas, Texas determined to see if Logo could actually enhance better thinking, learning skills, and problem-solving. Adhering to the concepts of exploration and discovery as the mode of learning, students from preschool classes up to grade four used Logo (with the inclusion of special procedures called sprites) on a regular weekly basis. Results from the study tentatively support Papert's claims that Logo helps improve general problem solving skills (Gorman, Jr., 1982). More conclusively, Nelson (1981) and Dafoe & Leventhal (1981) state that Logo helps children improve in peer-interaction skills, develop a more positive self-image, acquire a sense of co-operation and learn how to share ideas through teaching one another newly discovered procedures.

Logo research carried out at Bank Street College, New York also focussed on directly addressing Papert's claims regarding programming and problem-solving abilities. According to Karen Sheingold, director of the Center for Children and Technology at Bank Street College, children given 50 hours of Logo programming did not perform significantly different on tasks designed to test for problem-solving than children who did not receive Logo. Badger (1983) of Massachusetts Department of Education confirms Sheingold's findings in relation to research conducted in the Cambridge schools. Results on transfer skills regarding Logo and pen and paper drawings were non-significant between an experimental Logo group and a control non-Logo group.

With respect to Papert's (1980) claims regarding Logo and what it can do for learners, additional research has failed to conclusively support said claims. Lowd (1982), Bandeler (1982), Solomon (1982), Upitis (1982), Billstein (1982), Watt (1982), Riordon (1982), Shapiro (1982), Williams (1982), Bull and Tipps (1983-84) and Torgerson (1983-84) have all reported research findings on Logo use within classroom settings from the preschool to Junior High school level. Their findings support the use of Logo to develop confidence in self, peer-interaction, high interest levels, and social skills. Their findings reported general perceived increases in problem-solving, transfer of knowledge regarding mathematical concepts, procedural thinking, programming abilities, and increases in cognition. None of the studies reported data results using either observations with significant inter-rater reliability score or statistical analyses to support the claims.

The research suggests that Logo may be used in the classrooms as a vehicle to develop the affective domain of the learner, to enhance social and communication skills and to allow the students to experience a sense of success and self-worth while developing an individual learning style. There is no evidence to support Papert's claims that Logo is a tool for developing higher cognitive skills. However, it must be stated again that few of the studies reported actually used the discovery method Papert advocates. Most of the studies reported that Logo was taught to the students and that the students then experimented with the designs. As well, Krasnor and Mitterer (1984) state that current Logo literature is open for criticism from an experimental viewpoint. Lack of objective measurement in many of the reported research studies invalidate many findings. Rousseau and Smith (1981) also expressed concern over the lack of evidence supporting Papert's claims found in Mindstorms. Although there is a deficiency of conclusive, statistical results supporting Logo, there are excellent tentative hypotheses which should be pursued.

Papert Supported

Of the forty-eight studies reviewed, one study did report results in support of Papert's claims. Hines (1983) conducted a study in which she attempted to determine if five year old children could perform computer programming tasks. Using a pre and posttest design, she administered three testing instruments which encompassed number and letter identification, spatial concepts and number quantity, a fifteen question interview regarding attitude and understanding of the computer, and nine Piagetian tests on conservation, seriation and classification. Based on the test results, Hines (1983) found that five year old children could indeed use the computer as a tool for problem-solving and thinking through Logo programming concepts. This was the only research study reviewed which directly addressed Papert's claims concerning the effects the Logo language had on young children's cognitive abilities.

While many studies can be found supporting the use of Logo in Early Childhood Education, studies can also be found opposing its use. Barnes and Hill (1983) state that children should be at least in the Piagetian state of concrete operations before they are introduced to microcomputers. Their rationale is based on their belief that pre-operational children require large amounts of gross-motor activities; activities which work (or play) with microcomputers could not provide. They further expand upon the concept of a young child requiring real-life experiences in order to develop problem-solving processes and experimentation abilities. While viewing Logo as a potential medium for such concepts, Barnes & Hill (1983) state that Logo requires children to learn precise commands before anything can be done. Nevertheless, it can be proven that the instant forms of Logo developed for young children encourage experimentation with the turtle via one key stroke commands often with graphic symbols over them to visually depict the subsequent action of the turtle upon pressing the key. Gross motor activities are only a part of the young child's growing and learning process. Play with a robot turtle serves to enhance, not limit, gross motor activity, as stated by Papert (1980).

Chin (1984) documents the concerns from parent and educators regarding preschool computing. Relating it to the T.V. phenomena where the T.V. becomes a surrogate parent, Chin (1984) stresses that preschool children benefit more from the shared interaction between the parent and child while playing with and/or on the computer than by using it alone. She concludes that the computers' importance lies in the area of social interaction which is fostered through the sharing of computer knowledge by the students. An important point also stressed is that the computers should be regarded for what they are– another learning tool for the children to explore with.

SUMMARY

The research presented indicates a need for further study in the area of Logo and preschool education using the play approach as recommended by Papert. As well, a review of the literature in the area of Logo in Early Childhood Education reveals a lack of evidence supporting Papert's (1980) claims regarding transfer of learning, problem-solving and development of higher level cognitive abilities. This could be due to the fact that few studies used Logo the way Papert states it should be used.

Most of the studies reported observational data supporting Logo's use as a tool for developing social interaction skills amongst children, for creating a greater sense of confidence and self-worth, and for helping in the acquisition of co-operative and sharing skills. Two studies were found opposing the use of Logo for young children and advocated their use in higher grades-levels only. The rationale for these studies was based on the belief that microcomputers limited the freedom of young children to experiment and participate in gross-motor activities. Out of all reported studies, only one study was found actually measuring the Piagetian concepts Papert claims Logo was designed to enhance.

It is the purpose of this study to investigate the use of Logo in a preschool setting using the play approach to learning and to determine if Logo will affect the ability of young children to decenter. Decentering is the Piagetian concept of being able to think simultaneously in terms of the whole and its parts (Ginsburg & Opper 1969). With reference to preschool children, their ability to decenter could refer to their being able to see the difference between a whole collection of shapes and the individual characteristics of the shapes themselves. Donaldson (1978) has defined decentration as the ability to move freely from one point of view to another, either in the literal or metaphorical sense (p. 152). Decentering is the concept being focussed upon in this study as it is seen as one of the "higher cognitive Piagetian abilities" Logo is supposed to enhance.

The following chapter will present the research hypothesis, methodology employed and limitations of the study regarding the use of Logo in the preschool environment used in this study.

CHAPTER FOUR

The Method

The Problem

A recent trend in classrooms utilizing microcomputers is the adoption of Seymour Papert's innovative computer language Logo. Papert advocates that through Logo, children will be able to learn basic Euclidean geometrical concepts in an interactive play approach. He relates the experience as being similar to learning French while living in France (Papert 1980). Much of the literature on Logo shows how the language helps children develop socially but does not address the question of whether Logo helps children attain higher cognitive skills than children who use other available computer assisted instructional (C.A.I.) software.

The purpose of this study was to determine if young children of preschool age who use Logo will acquire the ability to decenter more than the same age group of children who use only regular drill-and-practice and games oriented C.A.I. programs.

Main Research Question

Will the use of the computer language Logo help children acquire the ability to decenter more than the use of C.A.I.?

Research Hypothesis

Use of the computer language Logo is more effective in developing the ability to decenter than is C.A.I.

Null Hypothesis.

There is no difference between children who use the computer language Logo and children who use C.A.I. in their ability to decenter.

H_0: Experimental Group 1 = Experimental Group 2

The Setting

An integrated preschool in a university setting was selected as the site for this study. The preschool used a play approach to early childhood education. A play approach emphasizes exploration, experimentation, and interaction within the preschool environment through play. The teachers within the preschool structured the daily curriculum toward the aforementioned play approach and provided an ideal environment where their role became that of a facilitator of learning.

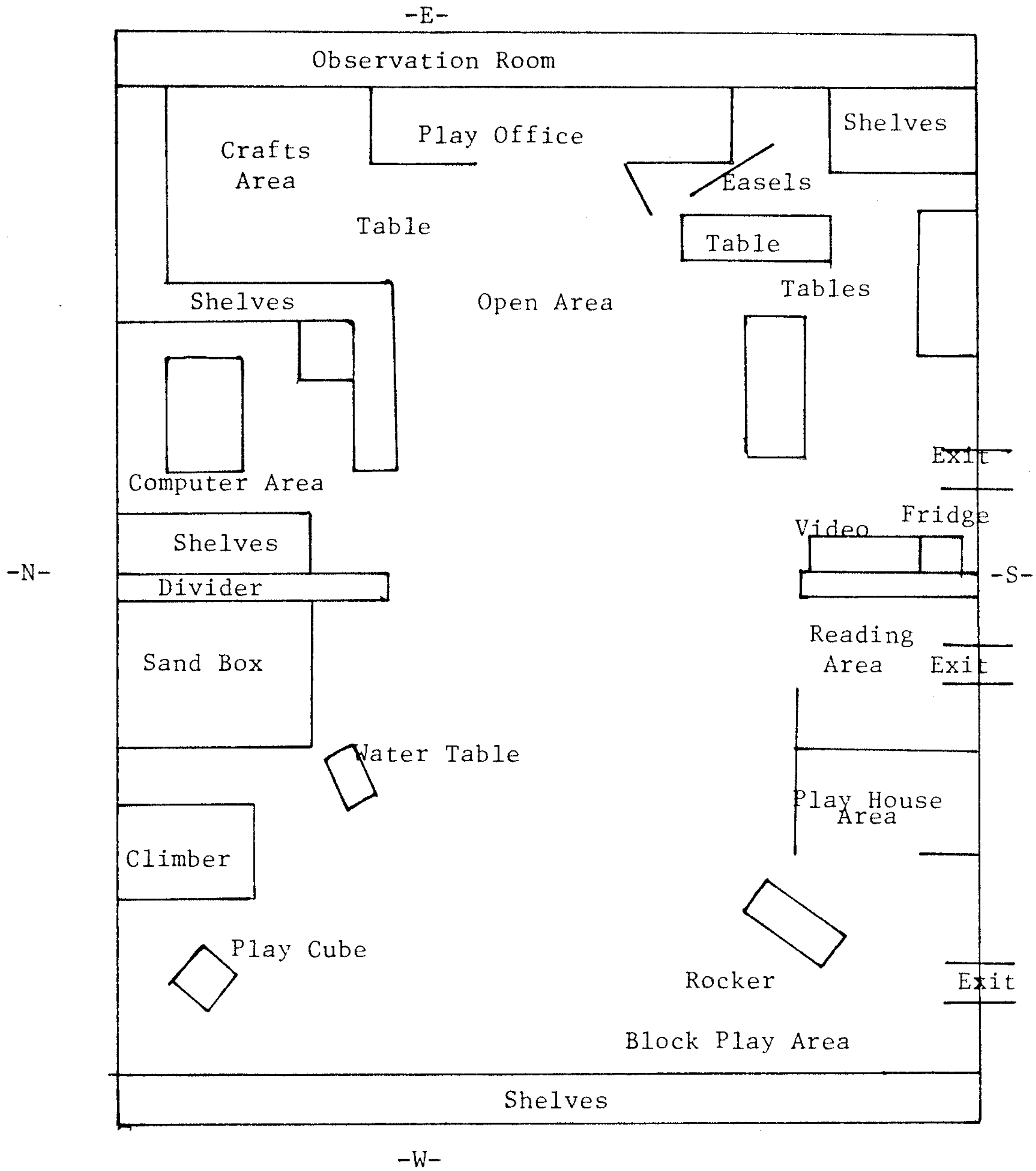
The preschool was used both as a practicuum setting for fourth year Early Childhood certification students and as a research setting for graduate students in Special Education.

The preschool was housed in a room with various sections designated for specific purposes. There was a reading corner, block play corner, playhouse area, gym mat area, climber, watertable, sandbox, drawing and arts corner, a play office area, supply area, fridge and video equipment area, and a computer area. Large, open, play areas in the center of the room provided space for gross motor activities such as large group games, play cars and small group adventure activities, etc.. Drawing and arts tables were converted into eating tables during snack time (see Figure 1).

Each area had distinct boundaries although they were not recognized

Figure One

Preschool Plan



instantly as such. Varations in room atmosphere were common when comparing the various areas, eg. the calm reading area as opposed to the dynamic block play area.

The computer center was segregated from the rest of the room by low shelves on two sides placed against an outside wall and a tall supply shelf making it an open area with the appearance of being enclosed (see Figure 2). The preschool underwent renovations in March resulting in the block play area being moved beside the computer area. New computer tables built to specification for the children and the computer area created a more open, interactive environment. By this, it is meant that the area was made more serviceable for young children by scaling the computer furniture down to their size; this opened more floor space for the floor turtle to move around in and for the children to play on while using the computers.(see Figure 3).

Sample

The sample for this study was drawn from a university based preschool population. The sample ranged from 30 months to 60 months in age and consisted of 46 students in total. The composition of the population included racial , economic, social, and parental education diversity.

The students were divided into morning and afternoon classes and most students attended an average of two out of four classes per week. Included in the total population were four special needs students. These students had varying degrees of mental handicaps and were involved in a mainstreaming program within the preschool. Pre-study observations over a three month period in the spring of 1983 did not reveal any notable effects on interaction between the children regarding the integration factor.

Figure Two

Computer Area Plan

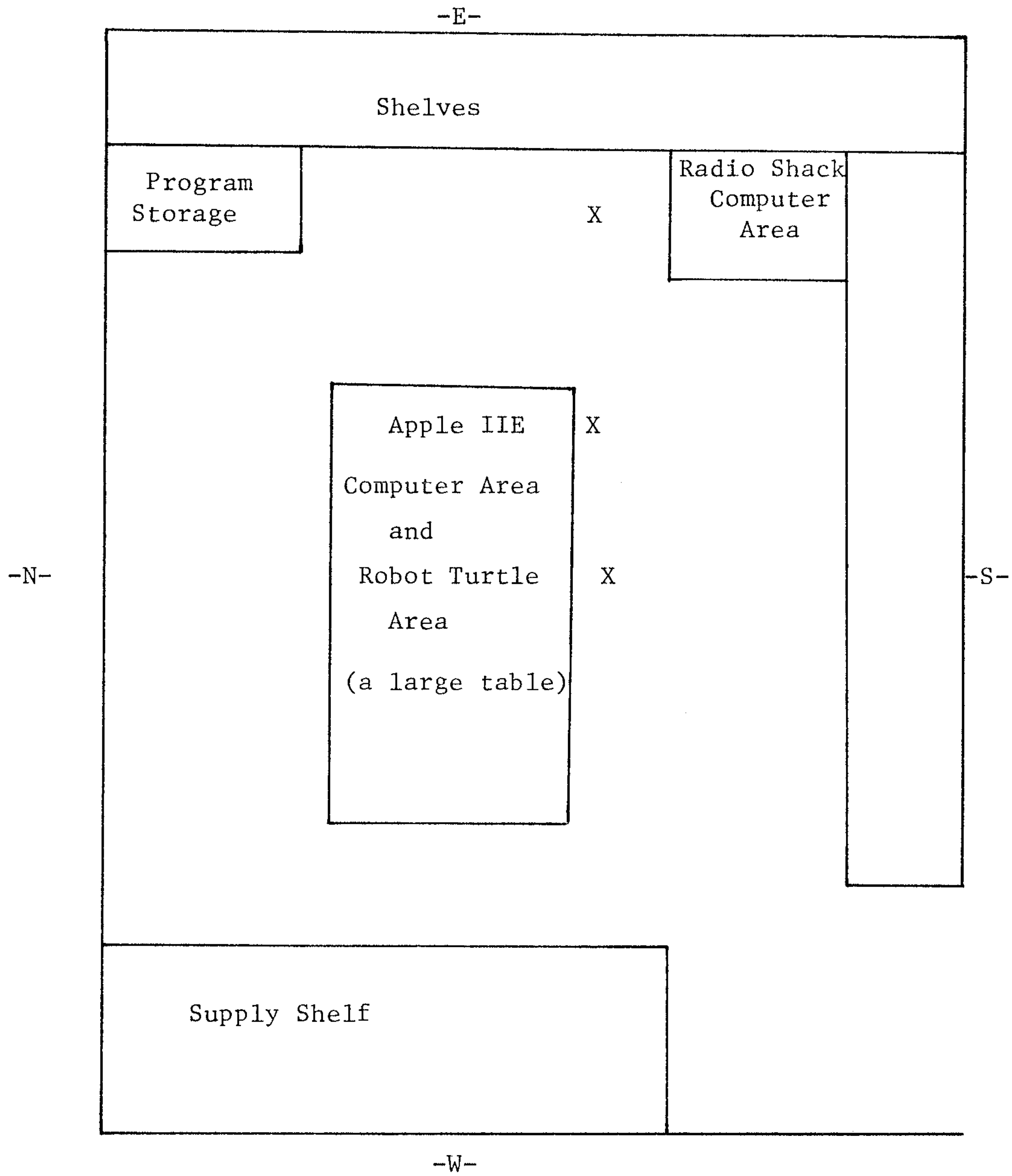
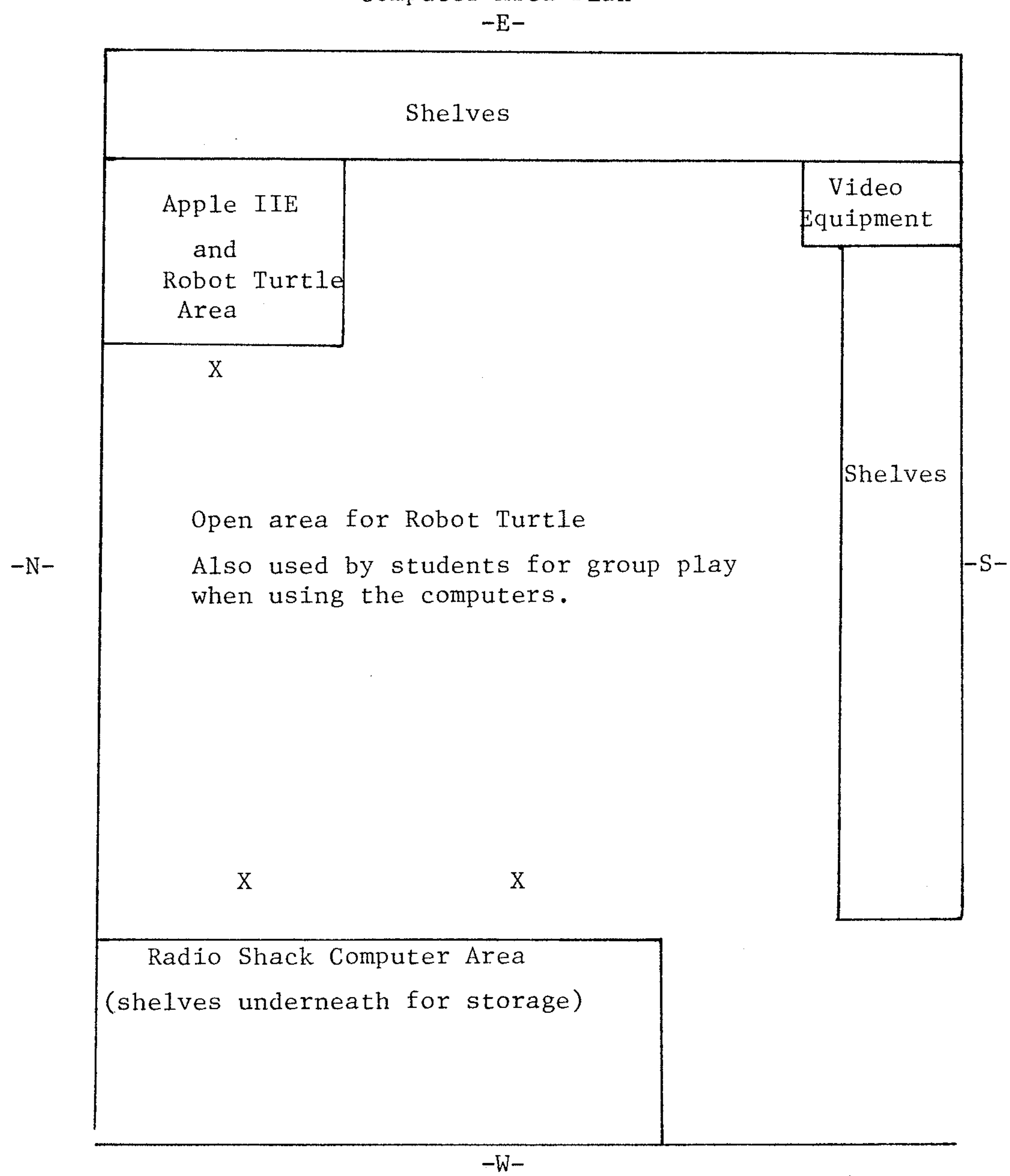


Figure Three

Computer Area Plan



The study sample was comprised of 46 students of which 21 students formed the A.M. sample group and 25 students formed the P.M. sample group. The proportion of males in each group was .42 percent and .40 percent respectively.

Demographic Chart

	Mean Age	% Male	% Female
Group 1	45 Months	.42	.58
Group 2	45.8 Months	.40	.60

Instructional programs

The main focus of this research was to determine the effects of the Logo language on young children's ability to decenter. When selecting the Logo programs to be used ,however, certain conditions had to be met. The population under study had obvious limitations and the programs used had to take these limitations into consideration. Reading skills of a preschool population are primitive. Language development is undergoing rapid change and memory capabilities are as yet limited. The ability to handle abstract concepts is underdeveloped at this age as well. A further consideration is the limitation of fine-motor co-ordination. Young children are physically unco-ordinated with regards to fine muscle movement. They prefer to participate in gross-motor activities, but this may also be a result of their short attention span to low activity level games.

Programmes Chosen

The programmes employed also had to take into account the mode young children use to learn with. Children master a concept through exploration resulting in their ability to play with the concept. "It is through play that the young child recreates the world and comes to understand it, his play is predicated on his experiences. Play is not aimless or purposeless or undirected. It is the child's attempt to achieve, to feel comfortable, and hence to be able to innovate and change his world"(Weininger,1979,p.5).

Based on this reasoning, the Logo program chosen had to accommodate these physical and cognitive conditions as well as comply to the play approach of learning. The Logo language chosen was not a 'true' Logo language. It was a variation of Logo designed for use with young children who are unable to understand the syntax inherent in a 'higher-level' Logo language.The following is a description of the programs used in this study:

Radio Shack Color Logo Program- The Radio Shack Color Logo is a turtle graphics language program based on many of the ideas in Logo (Watt, 1983 p.162).

> Color Logo has four operating modes: Run, Edit,Break, and Doodle. In Run, you can give commands to the turtle. In Edit you create or edit procedures. Break is used to move between Run and Edit, to save procedures on a disk or cassette, or to print them with a printer.Doodle allows young children to create turtle drawings by pressing singles keys
>
> Watt, 1983 p.162.

Apple Logo Program- The Logo program for the Apple IIE microcomputer consists of two separate instructional programs, the Tasman Turtle program and

Terrapin/Krell Logo program.

The Tasman Turtle program has an Instant Turtle Command subprogram which utilizes one key symbolic representation for controlling the robot turtle's movements.

The Terrapin/Krell Logo program is the version originally developed at the Massachusetts Institute of Technology. It includes list-processing capabilities, edit mode, separate procedure definition mode, screen-copy printing capabilities, and a feature for saving turtle graphics directly onto a disk.

The Terrapin/Krell Logo program is more complex for young children to use than the other Logo programs mentioned. Use of this program was limited meaning that it was only used when it was determined that the children were at a level where they could comfortably work within the framework of the language. It was possible that the program would never have been used. However, near the end of the study, a few children expressed interest in using the program and demonstrated their ability to do so. Their use of it was very brief consisting of approximately ten minutes of use during the two days when they expressed the initial interest.

Computer Assisted Instruction Programmes:

Radio Shack Sesame Street Software- These programs all utilize a highly graphical, games oriented approach towards the learning of basic skills and include sound effects and color.

With the exception of Ernie's Magic Shapes , all of the programs control screen figure movement and answer selection by use of a joystick.

Cookie Monster's Letter Crunch- This program is designed for the single user and focusses on letter and word matching skills. The student is required to select the correct letter from a group of letters to complete a word which will match either a displayed or previously displayed word. Various difficulty levels are available.

Ernie's Magic Shapes- The program is designed for the single user and teaches basic color and shape matching skills. Students are required to select a shape that matches a shape either displayed alone or within a complex figure. Selection is accomplished by choosing either the up-arrow key signifying 'yes, the shape is the same', or the down-arrow key meaning 'no, the shape is different'.

Peanut Butter Panic- This program requires cooperation between two players in order to 'build' peanut butter sandwiches. Essentially, it is designed to teach cooperation and strategy skills. Students must catch stars in order to build 'sandwiches' and score points. One student can propel another student's player higher onto the screen to catch bigger stars. The students must use co-operation and common -goal orientation to successfully play the game.

Star Trap- The program is totally games oriented and focusses on cooperation between two players in order to catch a 'star' and therefore win the game. The program requires one or more students to work within an obstacle filled maze. Eye-hand co-ordination as well as player co-operation is required.

Taxi- This program teaches cooperation and basic money skills as players attempt to run a taxi company. Based on a city map format, students must co-ordinate their movements to pick up fares and drive them to their designation using the safest and most economical route.

Computer software used on the Apple IIE computer were:

Gertrude's Puzzles- This program is designed for an older age group than preschool students but its graphic orientation appeals to the younger age group. The student is required to match shape attributes to construct a puzzle via 'Gertrude'. Specific keys are designated as directional movement keys. Manual dexterity , memory and concentration skills are required.

Rocky's Boots- This program is also geared towards the older age group but it's graphics orientation produces a high interest level from the younger students. The program essentially teaches Boolean math principles through the construction of electrical circuits, etc.. The student is required to fit specific circuit parts together to form a complete path for the energy flow. Movement is accomplished via specific directional keys. Memory, concentration, and manual dexterity skills are required.

NumBig- a number and letter recognition program from the Manitoba Computer Assisted Learning Consortium. Large scale numbers and letters appear on the microcomputer screen. The child is required to identify them by selecting the corresponding key.This program is for use on the Apple IIE microcomputer.

Materials designed by researcher.

A preschool activity package developed by the researcher was used in conjunction with the Radio Shack Logo program. The package consisted of Logo drawing activities based on the Piagetian concepts of generalization, conservation of length, and ordering. The activities were designed based on the requests of the preschool students who had been involved in the initial observation study in the spring of 1983.

The activities are described as follows:

Cards- Two packages of cards similar to playing cards contained the sequences for drawing either a square or a triangle. Cardboard posters depicting the drawings the cards represent were displayed above the cards. The children were free to choose a deck of cards to help them draw the pictures when using Doodle Logo.

Crazy Cards- Packages containing random ordered symbols for Doodle Logo turtle movements were available for interactive card game sequences. The children were encouraged to use their imagination and order the cards into a sequence of their own design.

House- A picture of a house comprised of a square with a triangle on top of it for a roof was placed beside the cards. A turtle was depicted asking the question "Now, can you draw a house?"

Maze- A sponge puddle was placed on one corner of the Radio Shack Color Computer screen with a larger sponge pond placed in the opposite corner. Felt arrows pointed the way from the puddle to the pond in a random, directional manner going around a felt tree. The child was required to direct the turtle from the puddle to the pond following the arrows. This activity involved right and left manipulations of the turtle. These manipulations were very hard for the children to make. The children viewed the turtle from the egocentric viewpoint preoperational children (as defined by Piaget) possess. It proved to be quite hard for the students to realize that their orientation of right and left was not always the turtle's directional orientation. This phenomenon was also discussed by Solomon (1976) in a paper describing a seven-year-old child's experience with Turtle Logo. The child had consistent difficulty in manuevering the turtle in the direction the turtle was facing if it proved to be different than the direction the child expected the turtle to go.

Star- A transparency with a five-point star on it was designed to be placed over the Radio Shack Color computer screen. The child would be asked if he/she could outline the star using the turtle.

Posters- Various posters depicting turtle drawings done by the students using the Apple Logo system were placed around the computer area. This was done in the same manner as the hanging of drawings and paintings produced by the students when they worked in the arts corner. Students were then able to look at their turtle drawings and use them as guides for further productions.

Turtle- A plastic toy turtle was placed beside the Color Computer for the children to practice spatial orientation skills while they worked with the screen turtle. This was to aid them in determining the orientation of the screen turtle.

Apparatus

The microcomputers and accessories used in this study were:

-Radio Shack 64K Color Computer with color T.V. monitor, single disk drive,and cassette recorder.

-ROM PAK Logo language package.

-Apple IIE 64K microcomputer with green phosphorous screen monitor, and dual disk drives.

-Tasman Turtle robot for use with the Apple IIe microcomputer.

The robot turtle was connected to the Apple computer by an interface cable.

Measuring instruments

Based on the Piagetian stage of preoperational cognitive development, the following pre- and post- test measuring instruments were used:

1) **Reversability Test-** 2 equal portions of plasticene were placed on a

table in front of the child. The child was asked to determine if the portions were equal. When equality was determined, one portion of the plasticene was rolled out into a snake-like figure. The child was asked if both pieces contained the same amount of plasticene. The snake-like piece was put back into its original form and the child was asked again if both pieces now contained the same amount of plasticene. The tester rerolled the piece of plasticene back into the snake form and repeated the question.

Criterion- If the child consistently replied that the snake-like piece contained more plasticene than the untouched piece of plasticene, he was considered to be in the preoperational stage of development concerning reversability. Renner et al.(1976) defines such a child as possessing the concept of 'irreversability' in thinking which is defined as "...inability of a preoperational child to hold mentally the image of an object and see that distorting the object does not change the amount of material it contains" (Renner et al.,1976 p.32).

2) **Transformation Test-** A wooden rod 10 inches in length was shown in an upright position to the child. The tester slowly let it fall sideways onto the table with it coming to rest in a horizontal position. The rod was left in the horizontal down position. The child was instructed to draw a picture of what happened to the rod.

Criterion- If the child drew a picture of the upright,or horizontal,or upright and horizontal position of the rod but failed to draw the intermediary step of falling he was showing the irreversability and centering traits of the preoperational child and was classified as such. The rationale for this test was that it can determine if the child can decenter the process of falling. (if the child can focus on the process, not just the beginning or end). In the stage of preoperational thinking, a child is so perception bound he can only see the beginning and end. It is beyond him at this point to be able to focus on the path of movement.

Classification Tests.

The rationale for using two tests of classification was based on Piaget's concept that levels of preoperational stages can be determined by the number of different concepts a child can manipulate at a given time. Lower level preoperational children can only comprehend two mutually exclusive concepts. IE. circles and squares, while higher level preoperational children can comprehend more than two.IE. circles, squares, triangles, and color.

3) **Classification Test A-** 3 large red circles, 3 large blue circles, 2 small red circles, 2 small blue circles, 3 large red squares, 3 large blue squares, 2 small red squares, and 2 small blue squares were mixed up and placed on a table in front of the child. Two 3"x4" cardboard boxes were placed in front of the child also. The child was asked to put together the things that were the same in one of the boxes and to put together the things that were the same in a different way in the other box. The child was told to use all of the shapes.

4) **Classification Test B-** 3 large circles-1 blue, 2 red; 3 triangles-1 red, 2 yellow; 3 large squares-1 red, 1 blue, 1 yellow; and 1 yellow half-circle were mixed up and placed on a table in front of the child after completion of the previous test. Two 3"x4" cardboard boxes were placed in front of the child also. The child was asked to put together the things that were the same in one way in one box and to put together the things that were the same in a different way

in the other box. The child was told to use all of the shapes.

Criteria- For both tests A and B all shapes were required to have been used and the classes formed had to display exclusiveness, IE., no two classes could share the same qualities, such as color and shape; all members of a class had to share common properties and the defining property of the class had to determine the members of that class(Ginsburg & Opper 1969).

A child was classified preoperational in classification if any or all of the following were shown: A) juxtaposition - the inability to see that several objects are indeed members of the same class, B) syncretism- the tendency to group together a number of disparate events into an ill-defined and illogical whole, C) small partial alignment- only some of the objects are used and they may be grouped in a picture forming sequence. The child does not group according to an overall plan (Ginsburg & Opper, 1969 p.120).

5) **Conservation of Liquid Test**- 2 identical, clear,glasses were placed on a table in front of the child. Each glass contained exactly 250 millilitres of purple paint. The child was asked if both glasses contained the same amount of purple paint. If he replied "no", he was asked to change the amounts so that they appeared equal to him . After equality was determined, the tester took one of the glasses and poured its contents into a short, wide, clear, glass jar. The child was asked if there was the same amount of purple paint in the jar as there was in the glass. The tester poured the paint from the jar back into its original glass container and asked the child if there was the same amount of purple paint in both glasses. When equality was again determined, the tester repeated the pouring process from the original glass into the short, wide, glass jar. The child was asked a second time if there was the same amount of purple

paint in both containers.

Criteria- If the child consistently replied that they were not equal, he was classified as preoperational in the concept of conservation of liquid. The test checked for continuous quantity, reversability, decentralization, and coordination of two concepts- height and width of liquids.

Reliability and validity of measuring instrument.

Few statistical measures are available for reporting on the reliability and validity of Piagetian tests. The test results usually support Piaget's theory concerning the age of the child and their cognitive developmental level.

For the purpose of this study, reliability and validity of the Piagetian pre-and post-tests was determined by whether or not the results supported Piaget's Developmental Theory. Since the tests were experimenter made,(following Piaget's original format), reliability was determined by consistency of results between the researcher and research assistants over time.

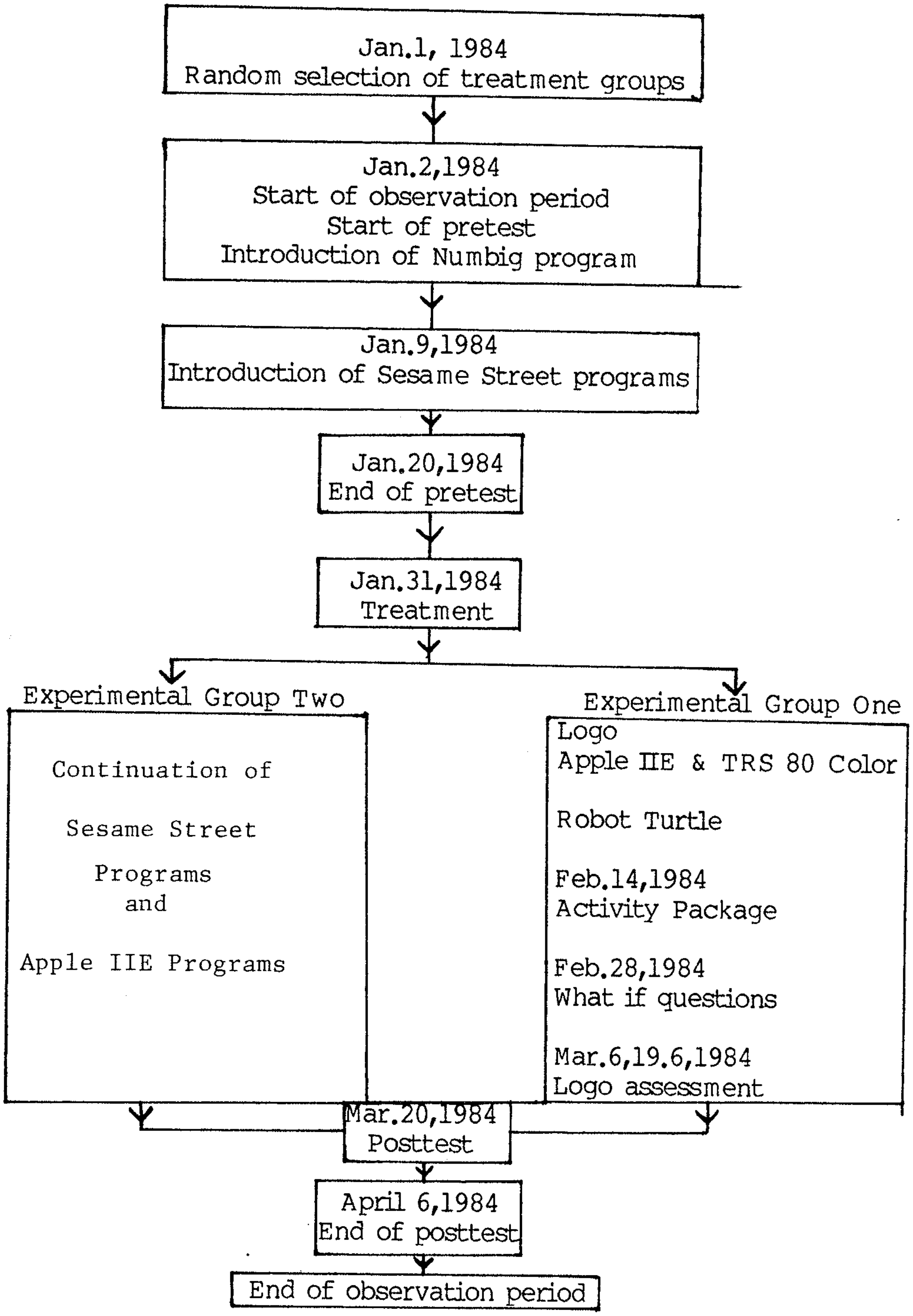
Validity was determined by comparing the results of the pretests with the proposed age guidelines as proposed by Piaget for each of the tests.

Method

The treatment began on January 2, 1984 and continued until April 6, 1984 for a duration of 14 weeks (See Figure Four).

Of the two groups involved in the study, one group was randomly assigned to experimental treatment one while the other group became the second experimental group. Experimental group one was given C.A.I. and Logo while experimental group two was given C.A.I. Herein, the groups will be referred to as experimental group one and experimental group two.

Figure Four
Flowchart of procedure



Pre-test administration

The Piagetian tests were individually administered as a pretest to each child by the researcher and a research assistant. Inter-rater reliability of the testers was determined by each tester administering the tests to the same five children. The test results were compared and found to have identical results as recorded by each tester.

The order of test administration was as follows:

1)Reversability Test

2)Transformation Test

3)Classification Test (A)

4)Classification Test (B)

5)Conservation of Liquid Test

Each test was administered according to protocol under Measuring Instruments.The pretest period started on Jan.2, 1984 and continued through until Jan.20, 1984.

The tests were tape recorded to free the tester from taking written notes during the testing session and to enable independent evaluations of interpretations.

Scoring procedure for the tests were based on a numerically coded pass ,fail, or in transition system (See Appendix A for sample scoring sheet and assessment).

Brandt (1972) and Willems (1969) recognize that results may be confounded if subjects are studied outside of their natural environment, as defined by the subjects. In accordance with this finding and to prevent contamination of results due to the testing setting, all subjects were tested within the preschool environment.

Introduction of the Numbig program was also done at this time. It was decided to introduce this program to both groups first in order to give all students an equal introduction to keyboard skills. On this measure, both groups were considered to have equal experience levels.

The observation data collection period started at this time also.

Treatment

The implementation date for Sesame Street programs was January 9, 1984. Both groups were introduced to the programs on this date. The introduction of the programs was done in the same manner as the introduction of any new toy. The programs were placed beside the appropriate computer and left up to the children to determine whether or not they wanted to use them. The motivation factor for a novelty item within the preschool setting was very high and it was utilized as way of getting the children interested in the new programs. Thus, the introduction of the various components of the research study was always met with high levels of enthusiasm and interest by the students involved. Motivation levels were never considered to present a problem.

Each child worked individually on the C.A.I. programs for a approximately 10 minutes during their weekly preschool attendance period. Through past experience with this situation (May-July, 1983) the realistic experience for each child occurred within a group user situation as opposed to the single user experience of computer time. Individual preference for the various types of C.A.I. programs available resulted in some programs being used more often than others. This was not interfered with as it would have contradicted the preschool's overall play approach to learning. However, all programs were used by all students at one time or another.

The introduction of Logo for experimental group one occurred on January 31, 1984. This was done in the same indirect manner as the introduction of the Sesame Street programs. As was expected, the novelty effect resulted in the program being immediately discovered and quickly put to use.

It was at this time that the robot turtle was placed within the computer environment. Again, the presence of a new 'toy' was considered to be enough to generate curiosity regarding its function and it also was quickly discovered and put to use.

From this point on until the beginning of the posttest period, the children were free to choose the programs they wanted to interact with. Experimental group one had the choice of using C.A.I., Logo, or a combination of C.A.I. and Logo programs. Experimental group two had the choice of the various C.A.I. programs.

On February 14, 1984, the Logo activity package was offered to experimental group one. This provided an expansion of Logo for those children who wished to go beyond the exploration phase but were not quite sure of what to do next. In this sense, the activity package was seen as a facilitator of further Logo experimentation.

February 28, 1984 was the date for introducing "What if..." questions to experimental group one when they used the robot turtle. For example, "What if the turtle wanted to go shopping. How would he go from his house to the store?" This would assume that the children had designated a "home" area for the turtle as well as an area that could be termed a shopping area or some other area external to the "home". It occurred that the children had designated a cardboard box home for the turtle as well as a "bridge" and "resting spot" under the computer table. The children used these places as destination points for drawing the turtle's path on brown paper taped to the floor using a felt pen placed under the turtle.

As the study progressed, the children learned how and when to take turns using the computers. The normal user situation usually involved two or more students working on the programs at once.

At this time, new games were introduced into both A.M. and P.M. preschool classes by the preschool teachers. These games were Brainy Blocks, Wee Shapes, and Three to Match and all three games involved color and shape discrimination and matching skills. This was initially perceived as an extraneous variable but both experimental groups consistently used the games and thus equated the groups on this respect. Originally, these games were to have been used as a measure of evaluation but it was decided that such games were part of the everyday preschool environment, much like the sandbox, wooden blocks, and reading corner, and could not nor should not be controlled for.

Experimental group one continued in this fashion until March 6, 1984. At this time, they were assessed as to their readiness for the use of the Apple Logo programs. This occurred via the students own request. Two of the students asked if they could try the program. They were shown the commands and their meaning. The students used the program sporadically over a two day period and attempted to show others their findings. Their interest dropped off when the other children refused to pay attention to their teaching attempts.

Both experimental and control groups were continuously encouraged to bring drawing materials, games, and mobile play toys such as stuffed animals, toys, cars, etc., into the computer area. The children were also encouraged to practice the educational aspects of the Sesame Street programs such as spelling, number and letter recognition, and shape discrimination, outside of the computer environment by the preschool teachers.

Posttest administration

Posttesting for both groups commenced on March 20, 1984. It followed the same format as the pretest. Piagetian tests used in the pre-test were repeated.

Observation Study

Nine months prior to the start of the hypothesis testing study, an observation study was conducted within the same preschool looking at the computer environment in general. The purpose of the study was to determine which behaviors within the computer environment were reoccurring, meaning occurring more than twice. This was conducted by the researcher and two other graduate students in Educational Psychology trained in observational techniques.

Methods employed were videotaping and continuous anecdotal recordings. The researcher and observers used both the active and passive participant observer format and naturalistic observations. This was accomplished by having one observer remain in the passive role throughout the study while the other observers adopted both roles.

The results of the initial observations generated the research hypothesis for the main study under discussion.

It was decided by the researcher to conduct an additional observation study while carrying out the hypothesis research to obtain a more comprehensive picture of the effects of computers on the preschool population. The specific purpose of the observation study was to collect data on the social interactions of the students while within the computer environment. A secondary purpose was to identify variables which were unknown or undefinable to the researcher prior to the start of the study. The data collection started January 2, 1984 and continued until April 6, 1984.

Rationale for Naturalistic Observation

Naturalistic observation- Ethologists interested in studying animal behaviour realized the value of obtaining data by observing the species in question in its natural habitat. Laboratory studies or contrived situations may allow the researcher more control over the variables under study but as Borkowski and Anderson (1977) state:

> The ethologist might also alter the environment in some way....However, such an intrusion would constitute a manipulation of conditions which goes beyond pure descriptive strategy and naturalistic observation. By manipulating the situation, of course, the environment is no longer natural (p.36).

In conducting naturalistic observation, the goal is to collect data in the 'natural 'environment of the subjects. For the purpose of this study, the 'natural' environment was the students' preschool classroom and as Gay (1981) states "The intent is to record and study behavior as it normally occurs"(p.169).

Participant observation- When conducting observational research, the researcher can adopt various roles by which the data may be collected. For this study, the participant observer mode was adopted. Gay (1981) defines this term as "In participant observation, the observer actually becomes a part of , a participant in, the situation to be observed. The rationale for participant observation is that in many cases the view from the inside is somewhat different than the view from the outside looking in"(p.170).

Two methods can be used within the framework of participant observation, active and passive participant. The active participant immerses him/herself wholly into the situation to be studied. He/she becomes a part of the environment and thus is able to gain data from the perspective of a member.

The role of the passive participant is the opposite of that of the active participant. The observer, in the role of passive participant, collects data from an unobtrusive vantage point in order to minimize the attention his/her presence may attract. Use of both methods results in an overall picture of the situation being studied.

McCall & Simmons (1969) revealed that the presence of an observer may affect the behavior of the population being studied. Gay (1981) states that observee bias occurs when the population being studied behaves differently because they know they are being observed. Use of the passive observation technique helps reduce this form of bias.

Methods of Observation

The methods used in this study were participant observer, utilizing both the active and passive roles, and naturalistic observations. This was in keeping with Piaget's studies of his children's activities whereby he collected his data using the naturalistic observation method (Gay, 1981).

The data were collected by the researcher and two research assistants.

Another graduate student working in the preschool collecting language samples helped record conversations which took place within the computer environment. All observers were trained in the collection of observational data.

The data were obtained through anecdotal recordings, videotapings, voice recordings, and still photographs. The main observation method employed was written anecdotal recordings. This was done for a total of 272 hours; two hours per preschool session for both A.M. and P.M. classes, four days a week for a duration of fourteen weeks.

Video recordings were taken when there were too many children in the computer area to record accurately by written observations. Voice recordings were employed for the same reason. Still photographs were taken as an alternate method of visually portraying computer-child interaction.

The researcher and research assistants consistently rotated the roles of recorder and active participant observer while conducting the study. This was done to allow the students the opportunity to become familiar and interact with all researchers involved. The researchers were also given a view of the project from both the recorder and active participant perspective. Furthermore, it provided a way of assessing agreement among observers and of reducing observer bias.

Statistical procedures.

Using the mainframe computer Statistical Analysis System (SAS) program by SAS Institute Inc., statistical analyses were done on the data obtained from the Piagetian tests. Due to the nominal and ordinal nature of the data, non-parametric tests were used. A Chi Square test was applied to determine the significance of the difference between the pre and posttest score frequencies of both experimental groups for each Piagetian test administered. In total, five two wap Chi squares were done. Descriptive statistics were also generated. This included frequency tables, means, and standard deviations for each test adminstered (See Appendix B). An overall correlation matrix encompassing all of the Piagetian tests was computed to determine if there were significant correlations between any of the variables. A Correlation test was also used to determine the relationships between the tests. In total, three 10x10 Correlation Matrices were analyzed.

Lunney (1970) has found that with respect to the statistical test ANOVA, both parametric and non-parametric data may be used. From a design point of view, it was decided to apply the parametric statistical procedures to the data to test if both types of statistics would produce the same results. Statistical procedures used included the General Linear Model Procedure which tested for effects between groups on each Piagetian test by applying the coefficients of regression equation to the data and the Analysis of Variance Procedure (ANOVA). The ANOVA tested for significant differences both between and within groups on obtained pre and post test results. A one way ANOVA was used for testing the data. (See Appendix B for ANOVA results).

The results of these tests are presented in Chapter Five, Results.

Limitations

Limitations of the sample

The preschool used in this study utilized the play approach to learning. This approach emphasizes the needs and wishes of the individual student and strives to fulfill these requirements by an accommodating environment. If a child wishes to draw while others are engaged in block play, this particular preschool is able to support the separate activities.

With such emphasis placed on individuality of the students, the computer area was required to fit the same criteria. Therefore, maintaining a closed, select, sample of students for participation in the research appeared to be a problem. Students could not be randomly chosen and assigned to specific groups if the environment did not support such rigidity. Therefore, all students in the preschool were participants and encouraged to utilize the computers. Given this parameter of the setting, both groups of children were classified as experimental groups. Availability of a group of children which could be studied as a control group without access to any computer influences was not possible.

Specific Limitations

1) Inability to control exposure time: All children in the population were encouraged to participate but none could be forced. Students who were not interested in the computers refused to participate and their decision was respected by the researcher. Those with a neutral interest were willing to use the computers on a regular basis if they were encouraged. Students who exhibited a very high level of interest in the computers used them consistently. Therefore, a major limitation was the inability of the researcher to control the amount of exposure time each student received on the computers.

2) Use of intact groups: Due to the research taking place within an educational setting, all members of the identified population had to be offered the same level of experimental treatment, as in keeping with the code of ethics regarding research with human subjects. The resulting sample being composed of the majority of the members of the population was based on a personal code of

ethics as well. It was felt unethical to randomly select sample subjects from the overall population when the interest level amongst all members for this particular study was so consistently high. Therefore, sampling statistics were not used due to the availability and willingness of the entire population to participate in the study.

3) Lack of a true control group: Since the objective of this study was to determine the effects Logo had on the ability of young children to decenter, a control group not using any form of computers as part of their environment would have been desired. The study would then have consisted of one group using C.A.I. and Logo, one group using C.A.I. programs only, and a control group not using any form of computers. Regarding the particular population studied for this research, the creation of a valid control group maintaining the same characteristics of the other identified groups was not possible. This was due to the play approach nature of the preschool which does not support restrictions on specific groups within the main population. Therefore, the assessment of differences between Logo, C.A.I., and conventional preschool programs was not feasible.

4) Inability to control for entering level: Some of the children would have had past experience with home computers, video games, and other devices that may have affected their entering behavior. However, this would hold true for any given population in that controlling for background experience is not always possible or ethically sound.

Limitations of the Instructional Programs

Every attempt was made to encourage the students to use all programs as consistently as possible. However, due to personal preference of the students for specific programs, some programs were used more often than others. As well, the students sometimes preferred to use the computers as typing instruments and would often request that the program currently in use be taken out. More often than not, the students would simply break out of the programs on their own and start creating their own 'program' using their imaginations to the fullest.

Thus, all programs were used by all children at one point in time but prolonged, consistent use was dependent on the personal preference of each child.

Limitations of the Apparatus

A limiting factor of the apparatus was the fact that the Radio Shack computer had a color monitor while the Apple IIE computer utilized a green phosphorous monitor. This may have resulted in more children gravitating to the Radio Shack computer due to the attracting power of the bright colors. This was considered controlled for though by the heterogeneous nature of the programs used on both machines.

CHAPTER FIVE

Results

The purpose of this investigation was to determine what effects the exposure to the Logo computer language had on preschool children's ability to decenter. Data obtained from the study using Piagetian pre and posttest instruments were non-parametric. Given the nature of the data, the statistical tests Chi Square, correlation matrices, frequency graphs, means, and standard deviations were applied. The raw data of the pre and posttest scores as well as the summary tables of the Analysis of Variance for the combined groups of each pre and posttest administered are found in Appendix B.

As previously stated (Chapter 4), the parametric test the Analysis of Variance was used to test if both types of statistical measures would produce the same results. The University of Manitoba's mainframe computer data analysis software program Statistical Analysis System (SAS) was used for the calculation of data results.

Experimental Results

Chi Square Analysis

The null hypothesis to be tested by the application of the statistical test Chi Square was:

There is no difference between children who use the computer language Logo and children who use C.A.I. in their ability to decenter.

H_0: Experimental Group 1 = Experimental Group 2

A Chi Square analysis was applied to the obtained pre and post- test score differences for each variable for both experimental groups. The Chi Square test was used to control for initial differences between pre and posttest scores between the two groups. For each presented Chi Square table of data, the frequencies are presented as occurring in units of .5. Therefore, if 19 frequencies are shown to be occurring at the 0 level it is interpreted to mean that 19 of the subjects did not advance or regress from the evaluated pre test level of preoperational thinking when evaluated on the post test. A plus or minus one represents one unit of .5 movement either up or down from the midpoint level of preoperational development. Plus or minus two represents two units of .5, or one full stage of movement either up or down from the preoperational level. Minus two is interpreted as being the stage of sensorimotor thought, minus one represents a transition stage between sensorimotor thought and the preoperational level, zero represents the midpoint level being studied, that being preoperational, plus one refers to a transition stage between preoperational thought and concrete thought and plus two means the concrete level of thought. For the purpose of raw data recordings, the .5 unit system of measurement was the easiest to apply.

The results for variable one, the Reversability Test, are found in Table

5.01. The frequencies of the scores falling within the range of +2 to -2 are refered to as units of .5. A score falling in the range of -2 would mean it is two units of .5 below 0, 0 being the preoperational level range of scores.

The critical value of Chi Square needed for significance at the .05 level was $X^2 = 7.82$ (df = 3). The obtained Chi Square was $X^2 = 2.834$. The null hypothesis with regards to variable one was accepted due to lack of significance between the frequencies.

Results of variable two, the Transformation Test, are found in Table 5.02. The critical value of Chi Square required for significance at the .05 level was $X^2 = 9.49$ (df = 4). The obtained Chi Square was $X^2 = 0.657$. For variable two, the null hypothesis was accepted due to lack of significance between the frequencies.

Table 5.03 contains the results of variable three, the Classification Test A. The critical value of Chi Square needed for significance at the .05 level was $X^2 = 7.82$ (df = 3). The obtained Chi Square was $X^2 = 2.185$, thus resulting in the acceptance of the null hypothesis for variable three due to lack of significance.

Results of variable four, Classification Test B are found in Table 5.04. The critical value of Chi Square required for rejection of the null hypothesis at the .05 level of significance was $X^2 = 7.82$ (df = 3). The obtained Chi Square was $X^2 = 4.465$. Therefore, the null hypothesis was also accepted for variable four.

Results of variable five, Conservation of Liquid Test, are found in Table 5.05. The critical value of Chi Square required for significance at the .05 level was $X^2 = 9.49$ (df = 4). The obtained Chi Square value was $X^2 = 3.109$. The null hypothesis was accepted for variable five.

TABLE 5.01

CHI - SQUARE ANALYSIS OF VARIABLE #1

REVERSABILITY

GROUP	TEST RESULTS					TOTAL
UNITS (.5)	-2	-1	0	1	2	
Experimental (1)	0.00 0.00 0.00 0.00	0.00 0.00 0.00 0.00	19 41.30 90.48 51.35	1 2.17 4.76 20.00	1 2.17 4.76 3.33	21 45.65
Experimental (2)	0.00 0.00 0.00 0.00	1 2.17 4.00 100.00	18 39.13 72.00 48.65	4 8.70 16.00 80.00	2 4.35 8.00 66.67	25 54.35
TOTAL	0 0.00	1 2.17	37 80.43	5 10.87	3 6.52	46 100.00

CHI-SQUARE = 2.834 DF = 3 $P > .05$, $X^2 = 7.82$

TABLE 5.02

CHI - SQUARE ANALYSIS OF VARIABLE #2
TRANSFORMATION

GROUP	TEST RESULTS					TOTAL
UNITS (.5)	-2	-1	0	1	2	
Experimental (1)	1 2.17 4.76 33.33	1 2.17 4.76 33.33	10 21.74 47.62 50.00	5 10.87 23.81 41.67	4 8.70 19.05 50.03	21 45.65
Experimental (2)	2 4.35 8.00 66.67	2 4.35 8.00 66.67	10 21.74 40.00 50.00	7 15.22 28.00 58.33	4 8.70 16.00 50.00	25 54.35
TOTAL	3 6.52	3 6.52	20 43.48	12 26.09	8 17.39	46 100.00

CHI-SQUARE = 0.657 DF = 4 P > .05, $X^2 = 9.49$

TABLE 5.03

CHI - SQUARE ANALYSIS OF VARIABLE #3
CLASSIFICATION A

GROUP	TEST RESULTS					TOTAL
UNITS (.5)	-2	-1	0	1	2	
Experimental (1)	0.00 0.00 0.00 0.00	0.00 0.00 0.00 0.00	17 36.96 80.95 51.52	2 4.35 9.52 28.57	2 4.35 9.52 40.00	21 45.65
Experimental (2)	0.00 0.00 0.00 0.00	1 2.17 4.00 100.00	16 34.78 64.00 48.48	5 10.87 20.00 71.43	3 6.52 12.00 60.00	25 54.35
TOTAL	0 0.00	1 2.17	33 71.74	7 15.22	5 10.87	46 100.00

CHI-SQUARE = 2.185 DF = 3 $P > .05$, $X^2 = 7.82$

TABLE 5.04

CHI - SQUARE ANALYSIS OF VARIABLE #4
CLASSIFICATION B

GROUP	TEST RESULTS					TOTAL
UNITS (.5)	-2	-1	0	1	2	
Experimental (1)	1 2.17 4.76 100.00	3 6.52 14.29 33.33	9 19.57 42.86 64.29	8 17.39 38.10 36.36	0.00 0.00 0.00 0.00	21 45.65
Experimental (2)	0 0.00 0.00 0.00	6 13.04 24.00 66.67	5 10.87 20.00 35.71	14 30.43 56.00 63.64	0.00 0.00 0.00 0.00	25 54.35
TOTAL	1 2.17	9 19.57	14 30.43	22 47.83	0.00 0.00	46 100.00

CHI-SQUARE = 4.465 DF = 3 $P > .05$, $X^2 = 7.82$

TABLE 5.05

CHI - SQUARE ANALYSIS OF VARIABLE #5
CONSERVATION

GROUP	TEST RESULTS					TOTAL
UNITS (.5)	-2	-1	0	1	2	
Experimental (1)	1 2.17 4.76 50.00	2 4.35 9.52 100.00	14 30.43 66.67 45.16	3 6.52 14.29 42.86	1 2.17 4.76 25.00	21 45.65
Experimental (2)	1 2.17 4.00 50.00	0 0.00 0.00 0.00	17 36.96 68.00 54.84	4 8.70 16.00 57.14	3 6.52 12.00 75.00	25 54.35
TOTAL	2 4.35	2 4.35	31 67.39	7 15.22	4 8.70	46 100.00

CHI-SQUARE = 3.109 DF = 4 P > .05, X = 9.49

Correction Matrices

Correlation matrices representing the correlation coefficients for the experimental group one, experimental group two, and both groups combined are presented in Tables 5.06, 5.07, 5.08, respectively. All five variables were intercorrelated with each other using both pre and post- test scores. The correlated variables are: the Reversability Test , the Transformation Test, the Classification Test A, the Classification Test B, and the Conservation of Liquid Test.

The value of r required for significance at the .05 level with N-2 (21-2) df for experimental group one was r = .433. With reference to Table 5.06, one of the obtained correlations was significant at this level.

The value of r required for significance at the same level (.05) with N-2 (25 - 2) df for experimental group two was r = .396. Referring to Table 5.07, six obtained correlations were significant at this level.

Using data from both the experimental groups, a correlation matrix was calculated for both groups combined. The value of r required for significance at the .05 level with N - 2 (46 - 2) df was .288. With reference to Table 5.08, eight obtained correlations were found to be significant at this level.

All relevant correlations for this study are circled on each of the tables. Non-significant correlation coefficients are discussed in the next chapter, Chapter Six, Discussion of Statistical Results.

Found in Appendix B are frequency graphs reflecting:

- the differences between pre and post test scores on all variables for both experimental groups.

TABLE 5.06
CORRELATION MATRIX
EXPERIMENTAL GROUP ONE

VARIABLE	PRE1	PRE2	PRE3	PRE4	PRE5	POST1	POST2	POST3	POST4	POST5
PRE1	1.0000									
PRE2	-0.0193	1.0000								
PRE3	-0.2712	0.0698	1.0000							
PRE4	-0.3786	-0.0569	0.5100	1.0000						
PRE5	0.3194	-0.1057	-0.2513	-0.0623	1.0000					
POST1	0.4976	-0.2314	-0.0830	-0.0838	0.2105	1.0000				
POST2	0.2041	0.1186	0.4152	0.4773	0.2257	0.0662	1.0000			
POST3	-0.2869	-0.1074	0.4780	0.3280	-0.1551	-0.3228	0.2928	1.0000		
POST4	0.0000	-0.3355	0.1677	0.1928	0.0000	0.0000	0.0883	0.4141	1.0000	
POST5	0.0000	-0.0355	-0.0237	0.0545	0.3611	0.2517	0.0625	0.1561	0.2651	1.0000

***SIGNIFICANT AT THE .05 LEVEL,
REQUIRED r= .396, df = N-2, (25-2)

TABLE 5.07
CORRELATION MATRIX
EXPERIMENTAL GROUP TWO

VARIABLE	PRE1	PRE2	PRE3	PRE4	PRE5	POST1	POST2	POST3	POST4	POST5
PRE1	0.0000									
PRE2	0.0000	1.0000								
PRE3	0.0000	0.2467	1.0000							
PRE4	0.0000	0.0000	0.4037	1.0000						
PRE5	0.0000	-0.1355	-0.2626	0.3326	1.0000					
POST1	0.0000	0.2291	-0.1211	0.0500	0.2494	1.0000				
POST2	0.0000	0.3610	0.3817	0.1181	-0.1747	0.0656	1.0000			
POST3	0.0000	0.1673	0.5013	0.2190	0.1012	-0.4107	0.2876	1.0000		
POST4	0.0000	0.0000	-0.0344	-0.0852	0.0709	-0.0266	-0.1119	0.2919	1.0000	
POST5	0.0000	-0.1954	0.2754	0.0852	-0.0709	0.2132	0.3079	0.1167	0.2727	1.0000

***SIGNIFICANT AT THE .05 LEVEL,
REQUIRED r= .433, df = N-2, (21-2)

TABLE 5.08
CORRELATION MATRIX
BOTH GROUPS COMBINED

VARIABLE	PRE1	PRE2	PRE3	PRE4	PRE5	POST1	POST2	POST3	POST4	POST5
PRE1	1.0000									
PRE2	-0.0175	1.0000								
PRE3	-0.2458	0.1460	1.0000							
PRE4	-0.2725	-0.0341	0.4504	1.0000						
PRE5	0.2582	-0.1172	-0.2573	0.0767	1.0000					
POST1	0.4712	-0.0677	-0.1303	-0.0223	0.2219	1.0000				
POST2	0.1150	0.2393	0.4040	0.3110	0.0517	0.0397	1.0000			
POST3	-0.2574	0.0113	0.4991	0.2727	-0.0682	-0.3691	0.2959	1.0000		
POST4	0.0658	-0.1785	0.0410	0.1004	0.0352	0.0546	-0.0272	0.3114	1.0000	
POST5	0.0583	-0.0949	0.0364	0.0799	0.2275	0.2835	0.1310	0.1048	0.3040	1.0000

***SIGNIFICANT AT THE .05 LEVEL

REQUIRED r= .288, df = N-2 (46-2)

- standard means for experimental group one.
- standard means for experimental group two.
- standard means of the differences between the pre and post test scores for both experimental groups combined.
- average standard deviations for experimental group one.
- average standard deviations for experimental group two.
- average standard deviations of the differences between the pre and post test scores for both experimental groups combined.

Summary

The results from the Chi Square test for each of the five variables tested supported the null hypothesis as previously stated. Correlation matrices applied to experimental group one, experimental group two and both groups combined indicated that there were relationships between some of the variables tested. Most of the relationships obtaining significance were found between variable one, Reversability Test, variable two, Transformation Test, variable three, Classification Test A, and variable four, Classification Test B. There were no significant relationships found between variable five, Conservation of Liquid Test, and any of the other four variables previously mentioned.

CHAPTER SIX

Discussion of Statistical Results

The statistical results presented in Chapter Five, Results, have supported the null hypothesis being tested in this study. Chi Square analysis has led to the conclusion that on the basis of the test results obtained using Piagetian testing instruments, the computer language Logo was not more effective in developing the ability to decenter than C.A.I. Upon close examination of the Chi Square analyses, it is recognized that in fact, the experimental group which did not use Logo showed more of a change in their development than the Logo group. This chapter will discuss the statistical results obtained from the pre and posttest data analysis. A general discussion of both the statistical and observational data as well implications for additional research will be presented in Chapter Eight, Conclusions.

Discussion of Statistical Analysis

The application of the Chi Square statistical test to each of the variables being tested in this study resulted in the overall acceptance of the null hypothesis. There were no significant differences found between the pre and posttest results in the areas of Reversability, Transformation, Classification A, Classification B, and Conservation. These results indicate that the children who used the C.A.I. programs only without having access to the Logo language showed the same types of learning concepts as measured by the pre and post Piagetian tests. In this instance, Logo did not affect the children's ability to decenter more than the children who did not use Logo. Close examination of the Chi Square analyses of each variable indicates that the group of children using C.A.I. only did improve in their performance on specific tests as compared to the group which received C.A.I. and Logo. Although the gains by Experimental group two were not statistically significant, the actual number of children who did show improvement requires attention.

As previously discussed in Chapter Five, Results, the Chi Square test was applied to the pre and posttest score differences for both Experimental group one and Experimental group two data. This was done to control for any individual differences between the groups which may have existed before the pretest was administered. With reference to the variable of Reversability, the obtained Chi Square of X^2 2.834 (DF = 3) was less than the required Chi Square of X^2 7.82 needed for significance at the .05 level. Therefore, taking the controlling nature of the applied Chi Square test into consideration, it can be said that there were no significant differences found between the Experimental group one and Experimental group two in their ability to demonstrate the concept of reversability. As in keeping with the age guidelines suggested originally by Piaget's Cognitive Development Theory regarding the acquisition of the reversability concept, both groups of children were found to be within the preoperational level of thinking. Examination of the actual numbers of the Chi Square analysis does show that four(4) more children in Experimental group two exhibited an increase in their ability to demonstrate reversability than the children in Experimental group one. Although this number is not statistically significant, it must be taken into account when comparing the effects the treatments may have had on the students. In this instance, it could be stated that the games oriented approach of the C.A.I. programs had a greater effect on the students than the Logo language and games combined.

The obtained Chi Square of X^2 0.657 (DF =4) for the variable <u>Transformation</u> was also less than the required X^2 of 9.49 at the .05 level of significance needed for rejection of the null hypothesis. Again, it can be concluded that the Logo language did not show any statistically significant effect on either group of children with reference to the concept of transformation. Although the raw pre and posttest results indicate that not all children were at the Piagetian preoperational stage of thinking with regards to this concept, (ten children in Experimental group one and eight in Experimental group two were classified as being at the concrete stage of thinking) the overall differences were not significant and therefore Piaget's theory was supported. Exact numbers showed that there was a difference of only two children in the Experimental group two exhibiting a greater upward movement as compared to Experimental group one.

Examination of the Chi Square Analysis for <u>Classification Test A</u> shows that the obtained Chi Square of X^2 2.185 (DF = 3) was less than the required Chi Square value of X^2 7.82 needed for significance at the .05 level. Close inspection of the data revealed that 16 of the Experimental group one subjects and 15 of the Experimental group two subjects were at the concrete stage of thinking with respect to this level of the classification concept and these subjects remained at this level throughout the study. Therefore, the actual fluctuations between the stages for the Classification A variable occurred for a minority of the subjects involved. Experimental group two did have four more children showing an overall upward movement regarding this variable. Piaget's theory for this concept of classification was not supported as the majority of the children were determined to be at the Concrete level of thinking, a level he generally associates with an older age group.

Classification Test B was also found to have a non-significant obtained Chi Square of (X^2 4.465 (DF =3)) at the .05 level. A Chi Square of X^2 7.82 was needed for rejection of the null hypothesis at this level. Therefore, it was concluded that no difference existed between the Experimental group one and Experimental group two with respect to a higher level of classification. Classification Test B, as described in Chapter Four, Method, involved the classification of objects on the basis of color and shape using more than two colors and shapes. None of the subjects in Experimental group one were evaluated to be at the concrete level of thinking with respect to this level of classification. However, one subject in Experimental group two was found to be functioning within the concrete level. Six subjects in the Experimental group one as well as three in the Experimental group two were found to be in transition on this variable. Overall, actual numbers indicate fourteen (14) children in Experimental group two demonstrated an upward movement in their ability to classify as opposed to only nine (9) children in Experimental group one exhibiting the same ability. For this concept, Piaget's theory regarding the suggested age levels was supported.

The last variable tested for by Chi Square analysis was that of Conservation. The obtained Chi Square of X^2 3.109 (DF = 4) was less than the required Chi Square of X^2 9.49 needed for significance at the .05 level. One subject in the Experimental group one showed upward movement from the preoperational level of thinking while one showed complete downward movement going from an original concrete level to a posttest level of preoperational. Three children within the Experimental group two had attained the posttest level of concrete functioning moving from the evaluated pretest preoperational level while there was a downward trend exhibited by one child within the same group. Two children in the Experimental group two were assessed to be in the concrete stage of thought for both pre and posttest evaluations. Overall, three (3) children in Experimental group two exhibited a greater upward movement than the actual number of children showing the same movement in Experimental group one.

Application of the Chi Square

The data obtained from the Piagetian pre and posttest scores were found by the application of the Chi Square statistical test to be non-significant in nature. The controlling nature of the Chi square test as applied to the pre and posttest score differences lends support to the conclusion that the computer language Logo was not more effective in developing the ability to decenter than C.A.I. However, with respect to the variables of Reversability, Transformation, Classification Test B, and Conservation, Piaget's suggested age guidelines for preoperational level of thinking were supported by this research.

Inspection of the actual numbers of children showing upward movement regarding the variables tested for depict a greater number of children demonstrating improvement in Experimental group two than those in Experimental group one. Although the results were not statistically significant, they do lend weight to the relevance of games oriented C.A.I. programs such as the Sesame Street programs used in this study and their usefulness in the preschool classroom.

Correlation Results

Correlation matrices were calculated for all variables for Experimental group one, Experimental group two and both groups combined. (See Table 5.06). The significant correlation occurred between the pre and posttest variable Classification A. This result, although inconsistent with the overall nonsignificance of the rest of the matrix, is consistent when the actual test results are examined more closely. Raw test scores indicate that the Piagetian concept of classification of objects using only two criteria was mastered and then maintained by the majority of the subjects (76% of Experimental group one, 60% of Experimental group two) when given the pre and posttest. This variable was the only one which had such a high rate of concrete level subjects throughout the entire study. One possible explanation for this high rate of correlation could be that the concept focussed on the classification of shapes or colors, attributes which both groups of children consistently had experience with and interacted with on a daily basis.

One of the C.A.I. programs used by both groups, Ernie's Magic Shapes, was directly related to this variable as it involved the identification of attributes of simple to complex shapes. This C.A.I. program was observed to be one of the most consistently used programs by both groups and is recognized to be a main factor in the results obtained by the Chi Square analyses. This observation will be discussed more thoroughly in the next chapter, Chapter Seven, Observational Data Results.

The correlation matrix for the Experimental group two, Table 5.07, reveals that six correlations were found to be significant at the .05 level, calculated r's being greater than the required r of .396 DF = 23. Significant correlations were found between the following variables: the pre and posttest scores of variable one Reversability (r=.4976), pretest scores between variable Classification A and Classification B (r= .5100), the pretest scores of variable

Classification A, and the posttest scores of variable Reversability (r= .4152), the pre and posttest scores of the Classification A variable (r= .4780), the pretest scores of the Classification B variable and the posttest scores of the Transformation variable (r= .4773), and between the posttest scores of the Classification A, and the Classification B variable (r= .4141).

Examination of the significant correlations reveals some consistencies amongst the data. With reference to the coefficients obtaining significance, raw data scores support the degree of correlation between the pre and posttest scores for the classification variables. It can be inferred that pretest and posttest results on Classification Test A can predict results on the Classification Test B variable. In keeping with the results of the Experimental group one, posttest results can also be predicted on Classification Test A from the pretest results on the same variable for the Experimental group two. Consistent with the raw data scores for the Experimental group two, it can also be inferred that the results of the pretest scores on the Reversability variable can predict the posttest scores on the same variable. Correlations achieving significance between the posttest scores of the Reversability variable and the respective pretest scores of the Classification A, and Classification B variable are not considered consistent with the overall data results. An assumption about the nature of a correlation matrix could be considered at this point. Such an assumption would be that given the nature of calculating a ten by ten (10 x 10) correlation matrix, the nature of probability would dictate that some correlations would achieve significance due to random chance. This assumption is used to explain the nature of the significance between these three aforementioned variables. In other words, the correlations are considered significant due to the chance of obtaining significance at random within a large correlation matrix.

Table 5.08 presents the correlation matrix of both Experimental groups combined. The calculated correlations produced nine coefficients which were significant at the .05 level with obtained r's being greater than the required r of .288, DF = 44. Significance was found between the following variables: pre and posttest scores of the Reversability variable (r =.4712), pre and posttest scores of Classification A (r = .4991), pre and posttest scores of Classification A and Classification B (r = .4504, R = .3114), pre and posttest scores of Classification A and posttest scores of Transformation, (r = .4040, r = .2959), pretest scores of Classification B and posttest scores of Transformation, (r = .3110), posttest scores of Transformation variable and posttest scores of Classification A (r = -.3691), and the posttest scores of Classification B and the posttest scores of Conservation variable, (r =.3040).

When discussing the significant correlation coefficients of both groups combined, some consistencies can be seen with these correlations and the significant correlations of the previous correlation matrices, the experimental group matrix and the Experimental group two matrix. Consistencies can be seen between the classification categories across all groups. Given this consistency, it can be stated that performance on the pre tests of these classification concepts can predict performance on the posttest categories. Again, this can be explained due to the nature of the concept , that being shape and color classification, and the consistently high interest level by both research groups in the corresponding C.A.I. program , Ernie's Magic Shapes.

Since it has been determined that posttest performance on Classification A can be predicted from the pretest performance on the same variable, it is not surprising to find that both of the pre and posttest score coefficients were found to be significant between the posttest scores of Transformation variable. Given also the significance of the correlation level between both classification variables, it can be expected to find significance between Classification B pretest scores and Transformation posttest scores. The relationships between the posttest scores of Classification B and Conservation variables can be explained as a result of the nature of the correlation and the probability of obtaining a random significant coefficient using a large n. This same assumption can also be applied to the significant negative correlation found between the posttest scores of the Reversability variable and the Classification A variable.

The correlations achieving statistical significance have been discussed in relation to their predictive nature for the Piagetian tests used. The coefficients which did not achieve significance have meaning also. By not achieving significance, these coefficients support the independence of the various testing instruments. The non-significant coefficients support the individuality of each Piagetian test used and lend credibility to the diversity of the tests themselves.

Summary of Correlation Matrices Analysis

For the three correlation matrices calculated, a total of 300 coefficients was obtained. Of these, it is recognized that only the significant coefficients found between the pre and posttest scores of the Classification A and Classification B variables could be utilized for their predictive value. The remaining coefficients were considered to have occurred on the basis of the probability of obtaining random significance given the total number of coefficients calculated. Non-significant coefficients were interpreted to lend support to the independence of the Piagetian tests used. As well, it is recognized that although inter-rater reliability for the Piagetian tests had a perfect correlation, the time factor between the administration of the pre- and posttest could have contributed to the development of decalage, an uncontrolled extraneous variable common to young children's cognitive development.

The following chapter will present the observational data that were collected throughout the study.

CHAPTER SEVEN

Observational Results

The statistical results presented and discussed in Chapters Five and Six provide evidence for the support of the null hypothesis of this study. Research questions posed in Chapter One however could only be answered by ultilizing observational data collection techniques in conjunction with statistical procedures.

The main categories investigated were social interactions and transfer of play topics of the children who utilized the computer environment. Using both active and passive participant observer format and naturalistic observations, anecdotal recordings were facilitated.

The following chapter will present the observational data collected during this investigation. Only data which was child initiated and occurring within or directly related to the computer area were recorded. The observations are presented together for the research groups and do not specifically focus on the Experimental group one or Experimental group two. A main discussion of the observations will follow in Chapter Eight, Conclusions.

Social Interaction

The children had already formed peer groups relative to the various areas in the preschool classroom prior to the start of this study. There were definite groups of children who played together in each of the specific areas of the room. It was observed that a group consisting of three boys, two of whom considered each other "best friends", utilized the computer area quite frequently. One of the children, who was a "best friend", displayed an extreme interest in the computers and assumed a dominating attitude and sense of ownership while in the computer area. The other two members of the group fought both verbally and physically with the third child after this interest level was recognized. The "best friend" situation broke up resulting in the child who had displayed the high interest level being ignored and/or teased by the other two chldren. The highly interested child then attempted to control the use of the computers when other children in the class attempted to use them. Since this same child had a very advanced reading level for his age, he used this skill to ensure himself constant computer useage time. The following verbatim recorded conversations demonstrate this concept:

S1 Loads Taxi program and gets an input/output error. S1. picks up the instruction booklet for the program and reads the loading instructions. S1. then reloads the program and continues to read the booklet. The program takes a long time to load. S1. sings 'Twinkle Twinkle Little Star while waiting. It finally loads and S1. presses the key signifying two players are to use the game. S2. Has been watching S1. go through the loading procedure. S2. notices S1. has pressed the two player key and starts to practice driving a car.

S1. Turns to S2. and begins to read the instructions of the game out loud.

S2. "I don't want to get hit!"

S1. "No, try to pick up that passenger. Now! Stop! Stop!"

S2. "I did it! I moved it there!"

S1. "Do you want to practice more?"

S2. Asks S1. to read the instructions again.

S1. "I want to play too!"(Picks up Twinkle book and reads.)

S2. "What's that, a musical book?"

S1. "Yeah.", (looks up from the book and says) "Pick up that passenger!"

(As S2. finishes, S1. chooses the 'More Practice' key saying) "I'd like to play with you too! I'm driving an orange taxi. Oh, it makes a different sound."

S3.. Comes into the area to ask what game they are playing.

S1. "I'm driving orange, S2. has green. I think I can get that passenger. I can't do it". (hands joystick to observer. Observer hands it back. S1. continues to move the joystick. Picks up passenger with S2.'s verbal help. Has difficulty dropping passenger off -again S2. gives verbal help. S1. appears very impatient and does not want to continue with the game. S2. and S1. attempt to move the taxis in order to finish the game.)

S1. Presses the button for a new city announcing "It's on side one." When questioned about the side it was on, S1. picks up the book, points out the section on cities, and then continues to read the book aloud.

<u>Additional Example:</u>

S1. Examines disk drive, types 'LOAD'.

S4.. (arrives) "Do you want me to play?"

S1. "Stop. Fine."

S4.. "Stop saying 'Stop fine'!"

S1. "You're not stopping."

S4.. "ON. That's easy!"

S1. "Have you ever made a word list?"

(they jostle one another)

S4.. "Sl. grabbed me on the cheek."

Sl. "Look! You spelled 'ON'"

S4.. "Yes, and 'NO' spells no. On. No."

Sl. (stops programme after S4.. leaves. Erases the word list and types in a new list.)

Sl. "Look what it gave me first!"

S5. "I never got to play this game."

Sl. "Would you like to play?"

S5. "Right after Sl. I'm going to work this one. Is this one (the joystick) broken?"

Sl. "Yes"

S5. "When are you going to be finished Sl.?"

Sl. "I'll see."

S5. "Probably you'll... I got..."

Sl. (interrupts S5.) "I made my own word list."

S5. "How does this..." (interrupted again)

S3.. "Could you help me out?"

S5. "I'm going to play this afterwards."

S6. (presses SHIFT button- then leaves.)

S5. "What are these for? No, these." (points)

Sl. "Ha, ha!" (whole body part of the machine) "K.O." (on screen, tickles himself under the arms) "It gave me the last one I put in. It spelled K.O. See the word I spelled. Booo." (smiles)" Nooo." (news). (Manipulates machine) "What I want to do." (erases word list, stands in the background)"I want to do more words!"

S7. approaches the machine.

Sl. "This is Cookie Monster---Crunch." (S7. picks up the other joystick)

S1. "It doesn't work. You know we're on a rocket? You drive the rocket while I play the game."

S7. "Look S1. He's Cookie Monster!"

S1. "He loves cookies." (leaves for snack, then returns.) "When do you want to end the game? Here, here! Other way, other way! (helps S7. with the joystick) Stop!"

S7. "Look, he ate his cookies already."

S1. "You need this one. Right here, stand it up. Time!" (your time is up).

S1. Leaves. S7., unable to continue without S1. stops. S1. returns after S7. leaves.

Peer Teaching

As the study progressed, it was also observed on numerous occasions that the preschool students would instruct each other in the use of computer games or Logo. This peer teaching has also been observed in other research studies focussing on the use of computers in a classroom setting. Researchers (Wright, 1984), Nelson (1981), Dafoe (1981) and Rheingold (1983) have also documented the "peer teaching" observation. Rheingold's (1983) article quoted Joan Targ (1983) as saying "children learn marbles or jacks without any help from adults, so why not let students teach each other about computers?..."

The previous conversations between preschool students demonstrated some of the peer tutoring concept. The following conversations further typifies the student teaching student concept.

S8. "Are you ready? See?"

S9. "Look (giggles). He walks!"

S8. "See he beats his- now right there. Steps and walks."

S9. "Talks to me."

S8. "Now I know. (S9. leaves, S8. plays with the joysticks, watches other children, general observation around the room.) "Water - up. There, look at that (points over S9.) Are you ready? See that? He's going to get the cookie. 'Drink' - I know what this is all about. Drin----Drink. You need a 'K', EVERY. See which one I need? I need this (to observer), it's more than just a game." (S9. arrives).

S2. "How?"

S8. "You press 'Fire' I copied it over. Let him eat his cookie! (to S9.) S9. pressed 'Fire' right away! This way (physically shows S9.) This way! This way! I'll show you, I'll show you! (S8. operates the computer) I'm helping S9. learn what it's all about! S9. always presses first. I'm letting (S9.) press 'Fire'- see!"

Teacher. "S8., let S9. hold the joystick."

S8. "I'm just teaching (S9.)"

S9. "S8. is not letting me press."

S2. "S8. will you let S9. hold the joystick? Would you like to start over?" (to S9.) (S8. is still operating the machine. S9. shakes her head- S8. attempting to get 'N' - a big one.)

S8. "Yup. See what happened? Now you choose the number you want. I..."

S9. "Yes."

S8. "You got one? Which will you choose- 2,3,4,5, or 6?"

S9. "5"

S8. "See which one S9. has to choose? (S8. operates) West. O.K. Cookie Monster."

S9. "Now you push red button, see! I wanna go and play over there now."

S7. and S10. arrive.

S8. "See what I have- Wine."

S7. "May I have a turn?"

S8. "No, You'll have to wait. Just a minute."

S7. "No. (S10.) Come here. See that under there? It's for another thing. (pointing to the robot turtle). May I try it now?"

S8. "He's drumming. Naw try. Two legs!" (S8. leaves)

S10. "That's mine."

S7. "That won't work."

S10. "Where is mine? I don't have anything to do."

S7. "See!"

S10. "It is mine."

S7. "You watch. I'll show you how it works."

S10. "It's wet outside. It's raining. When's my turn? (S7.) Can I do that?"

S7. "You just watch what happens. See, it's over 'I'."

S10. "Cookie Monster. (Monster eats cookie)"

S7. "Yum, yum, yum!"

S10. "No, it's paper. (both are watching carefully) Another 'I'. Doesn't work. Yes it does!" (greatly surprised).

S7. "Oh, oh, it is snack time. I'll come back later and do it. We'll come back later. Table isn't cleared off yet."

S10. "You don't have anything on your side." (to observer)

S7. "I do."

S10. "Me too. 'R'. Make it go to 'R'."

S7. "How do you make it jump?"

S10. "You don't have anything on your side." (again to observer)

S2. "Try 'R'."

S10. "No. No. We went to 'I'. He's Cookie Monster. (laughs) No. No. I want him on 'I'. Look, he went to 'F'. I like it at 'I'. Stop!"

S8. (coming into the area) "It's snack time."

(After snack, S9. and S10. come back into the area.)

S8. "If you are done, would you like to play this?" (offers them a board game.)

S9. and S10. are not ready to change.

Additional Observations

S1. Is sitting waiting for the program to load on the Radio Shack computer.

S11. runs in twice and looks quickly at the screen. S12. returns a third time, this time looking at the robot turtle.

S11. "What makes him go backwards?" (turns to S1.) "How do you play this game?" (referring to the Radio Shack computer program). "How do you make him turn this way? Which button? What makes him go straight?"

S1. "Push 'F'"

S12. "Blink, blink, blink." (Stops to watch S1. Points to Apple screen). "How do I play with this computer?" (he then leaves).

S13. Sits down at the computer and watches the turtle. S13. does not touch the keyboard. After a minute or so S13. says, "I can't find the right one. I can't find one." S12. points out the keys to S13.

S13. "Look, it turned around!" (continues to press keys and holds them down for some time). "Watch what happens when you press 'W'". (depresses the key then leaves. S17. follows).

S7. "It's blinking. I got it moving." (watches turtle).

S14. "You only have to push the ones with the tape."

S1. (to S14.) "Would you like to play with me?"

S14. "Sure."

They both notice snack and start to leave. S14. stops by the turtle and asks for a turn.

S14. "How do I make it go forward?" (S1. gives S14. the directions).

S14. "Good. How do I make it go backward? Right back. Good." (backs the turtle into the bookcase). "How do I turn it back?" (S1. give the directions). Speaking to himself, he says "Forward", (Smiles as the turtle goes forward).

Freedom of Interactions

It was observed most frequently that the children would freely move between the computer area and other areas of the preschool. The children carried over topics (themes) of play from one area into the other. This was partly attributed to the play approach nature of the preschool curriculum which supports the needs of the children to incorporate a variety of tools and toys into their play in order to gain full meaning from the play process. The computers were seen to be naturally assimilated by the children into the curriculum as well.

After the block play area was moved next to the computer area, some of the children carried over their play ideas from the block play area into the computer sections and vice versa. The following conversations describe an elaborately structured game being conveyed back and forth between the two environments. This conversation was recorded over a four day period. The theme of the play focussed on a space game and was stimulating enough to the players involved to capture their attention for a full four days.

Observations

Day 1:

S1. "How do you get this away?"

S14. "Good. How do you..."

S3. "Can I see this?"

S14. "No. A video game." (S1. is pressing the keys)

S14. "Up, up, straight. How do ....I turn around and go back?"

S1. "O.K. Good."

S14. "How do I make an I?"

S1. "See, he's going...straight up."

S14. "Good. Would you like to try this one? Yes."

S1. "Would you like to go back?"

S14. "How do I turn it?"

S1. "Anyway you want."

S14. "I want to down one."

S1. "He wants down! Up!"

S14. "Good. I have to go back up again." (presses keys with both hands).

S1. "Now I want a turn. Do you want to stop? Press this arrow. Now...See...O.K. ...Stop!"

S14. "Let's go back."

S1. "Oh no. Play with the other machine."

S14. "Good, (pleased with the results). I actually have to go down. Turn this turtle down."

S1. "Up! Up!"

S14. "Good. Good."

S1. "Would you like to go back?"

S14. "I'll try. Wait. Turn it on fast."

S1. "It skips right down. Did you see that? It skipped right back down. No. Press down. You need to press the big arrow. There -Enemies. You did it."

S14. "You didn't get us (referring to the enemies). You didn't!"

S1. "Now let me try it."

S14. "Good! (S1. operates the computer). Right down."

S1. "Oh, now press up."

S14. "Now push 'I'."

S1. "Oh no, I fired it. Oh no, oh no, oh no, there's enemies -a rocket out!"

S14. "Approaching missile. Quick, they're shooting at us. Smoke. They won't see you in the smoke. Enemies, quick!"

S1. "Oh no, oh no, oh no!"

S14. "Do you want to be 'BEAN? O.K. In the Dukes of Hazard."

S1. "Oh no - I'm not in a rocket!"

S14. "You can still be the Duke."

S1. "Oh, I have to put it...oh no. I have to turn. Oh no! Oh no! Oh no! Control is gone. No!"

S14. "We're heading downward. I'll switch on...quick, inside. Bad guys. I'll shoot."

S1. "O.k. NOW! Oh no, oh no. Enemies!"

S14. "Enemies. Quick. Enemies on screen."

S1. "I know. Oh I know. Bad guys- missiles. Kill them!"

S14. "I'll push red. Enemy fire quick (makes a lot of noises to accompany enemy fire). That was the helicopter."

S1. "Oh look! Enemies!" (very loud voice)

S14. "Good. Computer sho-oo-oot." (makes a shooting noise).

S1. "The killers are coming in ..."

S14. "We're in the helicopter. Oh no! Enemies! Approaching fast in helicopter." (great excitement, shouting, sounds created by S14. to accompany action). "Oh, goodbye."

S1. "Oh no! Enemies! Shot down. Then I shot the enemies. Oh no, we have to turn a corner. Oh no, try. Quick at the end!"

S14. "Enemies -quick. And they....missiles....bad guys...their armour is too strong for the Raiders. Put on full speed." (operating joystick).

S1. "He's not going anywhere. He's just printing out." (face all wrinkled up.)

S14. "Can you use this computer here?" (changes over to other computer). "Good. Quick!"

S1. "Snacking...oh no."

S14. "Bee be be. Control point. Fire! Quick! Do, do, do. Quick!"

S1. "It's not working."

S14. "Good. Let me do it. Wait."

S1. "I'm tired of playing. We wanna play a different game."

S4. "What are you guys playing?"

S14. "I don't know. (S1. leaves). There's base. There's screen. Quick."

S4. "Ha."

S14. "Wait a moment Captain. Do do do da da. Oh. There's something wrong. Do do do do da da do (pressing central key.) Here! Here! Play."

S4. "Don't you want to play with me instead of that?"

S7. (had been watching) "Now it's my turn."

S4. "What are you doing?" (to S14.)

S14. "Just wait. Home base..." (S14. then leaves and comes back a minute later).

S7. Slowly presses the keys with one hand.

S14. "You know what? In a real computer with a helicopter they don't have a tape on!"

S7. "I'm wearing a blouse today." (presses keys without looking).

S14. "What's this for?" (S7. looks and listens). "There's another shirt under here." (he's wearing two shirts).

Day 2 :

The children involved in the previous day's game entered the computer area and immediately continued with the same game theme as they had ended with the day before.

S3. and S1. at the Apple with 'Letters' board game.

S3. "Quick S1. ,I've got to drive the rocket. That's for a lot of rockets to chase after." (types using the 'Delete' key).

S1. "Oh no. Somebody's hurt at home."

S3. "I'll make all these rockets disappear." (uses 'Up Arrow' key).

S1. "I'm driving the rocket." (turns arrow on the 'Letters' game spin wheel).

S2. Joins in.

S3. "These rockets go really fast." (hits the space bar). "I'm making it really dark...so...can't see." (darkens monitor).

S1. "We have to make the rockets disappear."

S3. "Let's go fast..." (makes vroom noises). "Hey, we're driving the rocket!" (directs this statement to S2.).

S1. "Now I'm going on speed eight."

S3. and S2. leave.

S1. (speaking to the observer) "We have to chase one hundred rockets...one thousand. These are the rockets." (points to stationary screen cursors). "This is our rocket that chased him." (points to flashing cursor).

S3. and S2. return. S3. walks over to the Radio Shack computer and sets up the Doodle Logo program for S2. (program is already loaded into the machine but S3. breaks it out of 'Run' and sets up Doodle mode). S3. goes back to his seat at the Apple and S1. continues with the spin a wheel pretending he is driving.

S12. "Come on. There's a bad guy after us so I'm really going fast so he can't catch us. (Cursor streaks across the screen). Mmmmmmmmmmmm do do do do . There's a bad guy behind us. See that tree? (he points to a construction paper tree on the blackboard behind him). He's behind it, there."

S2. (on the Radio Shack Computer). "There's a bad guy after me. Deedeedeedee." (pressing keys while S1. and S3. inspect the spin a wheel).

S1. "Mmmmmmmm. We have to take one thousand rockets ."

S3. "All right S1. "

Day 3:

For the third day in a row, the same students continued to develop the space game theme within the computer area. It was noticed that their attention span for a game consisting entirely of the cursors on the computer screen and limited only by the scope of their imaginations was substantially longer in duration than what was observed for either the Logo language or the C.A.I. games. This has possible implications for developers of children's software meaning that more attention should be given to the desires, needs, and wants of children who use computer programs in order to ensure the provision of useful and motivating software.

S3. "The rocket is chasing people." (the cursor moves across the screen).

S1. "Just a minute, we have to press 'Space'."

S3. "Newton on Hercules, when something goes wrong always say 'Sufferin Succatash."

S1. "We have to chase one hundred." (turns machine off and on again).

S3. (Joined by S2.). "No, S2. don't do it." (S2. left).

S3. "I'll make it dark." (turns screen low) "So now, no one behind can see us."

S1. "I have to make the rockets disappear."

S2. (Coming back into the area). "Want some orange juice you guys?"

S3. "Sure." (S3. leaves).

S1. "We have to chase a hundred rockets, thousands."

S3. and S2. come back.

S2. (Goes to the Radio Shack computer).

S3. (Joins S1. at the Apple). "See that tree? (points to the construction paper tree on the blackboard). He's behind that." (the bad guy).

S2. (On the Radio Shack computer). "A bad guy's coming after me."

S3. (On Apple). "Well, we'll get him." (turns to S1. and they move the cursor across the screen. S3. continues to chase the bad guy who is after S2. using the separate computer while S1. runs between the two telling S3. and S2. how close they are to each other).

Day 4:

The space theme again continued for a fourth day between the same group of students. Other children had grown uninterested in hearing the conversations of the children regarding their game and had withdrawn from the area to play in other sections of the preschool. The involved students maintained the game theme but were observed to have exhausted their imaginations and/or interest level in the game. This may be attributed to the drop of interest displayed by their peers in their activities.

S3. and S1. run into the computer area.

S3. (Asks for the 'Letters' board game. He and S1. indicate they want to continue their rocket game. S3. sits down and types in letters on the Apple while S1. searches the classroom for the spin a wheel. When he can't find it, he returns with four blocks, each block having a number on it. S1. announces that the numbers can be his speeds)

S1. "See, I have speed." (S1. sits down with S3. who begins to type in 'Rockets').

S1. "We will go at speed eleven." (the number on the block he is holding. At this point S1. sees the spin a wheel and discards the blocks. S1. begins turning the wheel making various 'car' noises). "Mmmmmmmmmmm." (S1. then suggests to S3. that they should put in more rockets).

S3. "I can do what I want in my rocket. (turns down the monitor). So the bad guys won't see us."

(Both children continue to play in this fashion for five more minutes before they move off).

During the same time period, it was observed that a similar game was being constructed in the other research group. The main difference was that the experimental group utilized both the computers and the block play area while the control group brought blocks into the computer area but did not utilize the computer in any way. Both groups had "robots" as their main theme. This was partially attributed to the sudden influx of "Star Wars" movies and cartoons being shown on the television that week. For example, a child in the afternoon group constructed three very elaborate, four foot tall robots out of the blocks. To ensure against their destruction, he laid masking tape on the floor circumferencing the robots. The other children immediately interpreted it to be a pathway of sorts and followed it consistently over the next few days until the interest level dropped off for that particular game.

S7. "Follow the tracks! (the tape), Follow the tracks everywhere!!" (this was spoken over and over again in a singing voice).

Approximately two months after the research study started, the children in both groups started to exhibit a high level of interest in the board games Wee Shapes, Brainy Blocks, and Three to Match. The children in both groups immediately started to play with the games, but only in the computer area. In the control group, a very dynamic interactive situation was observed one afternoon. The situation involved a group of children playing with the board games on the floor while individual members of the group alternated between turns on the computer and their turn at the board games. The atmosphere within the area was very interactive.

This particular situation was considered important by the researcher as substantial proof of the acceptance of the computers as another "toy" by the preschool children studied.

Miscellaneous Observations

Other observations focussed on a variety of issues. It was noticed that one child, an E.S.L. student, was having difficulty making social-contact with other children. He would involve himself in parallel play activities with them but would avoid direct interaction.

In March, he walked into the computer area and joined another child using the computer. The other child left and he then changed seats in order to be directly in front of the keyboard. He started to press the keys randomly and got very excited when he realized the screen effect of the keypressing. The following is the conversation initiated by him during this episode.

S1. (using the Apple).

S19. (using the Radio Shack computer and the Ernie program). "He's playing wrong." (meaning Ernie).

S15. (Joins S1. Brings a chair over and sits beside him. Watches the teacher play with the Ernie game. S19. leaves).

S16. and S17. are in the computer area building with the large blocks).

S16. "This can be a computer place." (referring to what they are building).

S2. "Look". (S19. comes back and gives S18. instruction in how to play the game. They both leave after a few minutes have passed).

S15. "Look it! Look it!" (S1. Had left the Apple and S15. had taken over the seat. Would repeat this phrase everytime he put something on the screen by pressing random keys. This was the first time S15. had spoken. Whenever the observer looked away, S15. would touch her shoulder and redirect her gaze to the screen.) "Look it! Six c's, four c's, Look it! Look it! Where's 'P' ?" (S15. was then joined by the teacher. He proceeded to show her how to fill in the screen and then make it disappear).

It is not to be implied that the computer helped him overcome his shyness regarding direct interaction with people in the preschool. However, it can be postulated that the computer was instrumental in helping him gain a sense of social interaction and involvement.

It had been mentioned in Chapter Three, Method, that the preschool was integrated. An interesting observation involved one of the special needs students and his exploration of the concept of the cause and effect using the computer. The following anecdote describes the situation.

S18. (S18. had been shown how to turn off the monitor). "Disappear!" (S18. pressed 'Return' and then erased the screen). "Put it back!" (Pressed various keys to put characters on the screen. Kept repeating the process and jumping up and down). "I did it, I did it!" (S18. repeated this a few times and then went to the Radio Shack computer). "Put it up! It the same!" (The game Ernie's Magic Shapes was in the computer at this time. S18. had never played this game before, he had only watched. S18. was demonstrating that he was capable of playing the game). "Bunny, bunny." (S18. played this game for a few minutes and then went back to the Apple computer). "I did it! It disappeared. Put it back! I did it!"

One of the underlying aims of the research study was to try to get the computers accepted by both students and teachers as part of the preschool environment. To a certain extent, this happened. However, computers, even in a preschool where they are utilized as toys, carry with them a certain bit of awe. While observing the children use the computers, observations concerning teacher reactions were also recorded. An example of how "awe inspiring" the technology is for some people can be described as follows: One of the children was busy working on one of the computer games. It occurred that the child was required to reload the program at one point when another student accidently pulled out the plug to the computer. The child simply reloaded the program and then continued on with the game. One of the teachers, who had never displayed any interest in the computers, was overheard to say "I never thought -------- could do that." This also could be interpreted from the perspective that young children's abilities on computers may be underestimated.

The concept of animism, meaning giving life-like attributes to inanimate objects, should be considered when looking at young children and computers. Many adults often feel there is something magical or mystical about computers so it can be a natural assumption to think children may believe computers are alive in some way. One instance of animism was observed to have occurred during the study. The children in the experimental group were planting bean seeds in styrofoam cups in order to see their growing process. All of the children put their cups near a natural source of light with the exception of one boy. He placed his next to the computers. When questioned by the researcher as to why he was putting it there instead of in the window, his response was "Well, when I leave and go home, the computers and my plants will be all alone. I have to put them together so that my plant will keep the computers company and the computers will help my plant grow."

The concept of magic was also raised by a student in the control group. The following conversations relates the context of its use. It was a topic which occurred twice.

S20. "I've got magic fingers. We both have magic fingers, right?" (This was stated after S20. had found the repeat function of the keys. The students were required to leave the room at this time in order to help clean out the sandbox). "I can't go outside cause if I'm outside, I'll lose my magic. My fingers won't be magic anymore."

Researcher. "Well, you can leave the magic with me and I'll give it back to you when you come back in."

S20. "O.K. Here." (Slapped the researchers' hand and then left).

Second Observation:

S20. "I want to write, not play games."

S13. "I want to spell, don't put games on." (S13. spelled out her name, cleared the screen and then left to work on the Apple).

S20. "How'd you do that?" (to S13.) "It's my magic! I must have given you some!"

S21. "It's magic- look at it move! I can do it! I'm typing. Now I'm doing this."

S1. (playing a board game on the floor of the computer area). "I make potions. They are magic! It makes things back to normal. Actually, it doesn't help, but it makes things special. It makes magic with magic."

One last observation to be related concerns the amount of human contact the students wanted while working on the computers. Although they were all capable of working on them alone, they still wanted to know that they were being watched by a teacher. At times, the student would act helpless and expect aid from the teachers. This was interpreted as the students wanting attention and approval more than aid. It was observed that the amount of time they spent working on the computers was related to how much attention they were being given. The following conversation is an example of the students need for attention.

S21. "You watched him. (pointing to another student working on the Apple).You watched him press the buttons."

Observer. "Yes I did."

S21. "Don't you watch S9. and me?"

Observer. "Yes, I watch you too."

S21. "Oh, O.K."

SUMMARY

This chapter presented the most prominent observations recorded throughout this study. Social interactions, environmental interactions, and transfer of play topics, were considered to be the areas of prime importance. Other observations were reported but these were not of the same level of duration as the previously mentioned ones. With regards to language development, the child that was observed to have spent the most time within the computer area did not exhibit a greater language development than the other children. Most of this child's time was spent in giving orders to the other children and speaking using statements. However, giving orders could also be interpreted as a form of decentering as the order giver would be required to consider the other child's perspective and how it could be changed through directives. Using this interpretation, it could be speculated that the computer environment did influence this particular child's ability to decenter although it is not possible to directly link it to the use of the Logo language only.

The following chapter will present the conclusions and recommendations of this study based on both the statistical and observational data.

CHAPTER EIGHT

Conclusions

The conclusions, implications, and recommendations of the research are presented in this chapter.

Conclusions

The results of this study failed to support the hypothesis that the use of the computer language Logo is more effective in developing the ability to decenter than is C.A.I. Throughout this research, the subjects maintained the same level of development as defined by Piagetian theory regardless of the treatment effect they received. Observational data agreed with the findings of previous Logo studies that Logo facilitated the areas of social development, peer interaction, and peer teaching.

Implications

Before a final conclusion can be arrived at, cognitive development and subsequent measurement of development must be examined.

Development of a young child's cognitive abilities as defined by Piaget is not a steady progression from one stage to the next. Decalage, or time lag is a common occurrence for a young child to encounter. Piaget (1971) explains decalage as being related to lack of experience with a concept (such as conservation or class inclusion) using a variety of contexts within which such concepts can occur.

> At certain ages the child is able to solve problems in quite specific areas. But if one changes to another material or to another situation, even with a problem which seems to be closely related, lags of several months are noted, and in some cases even of 1 or 2 years. (Piaget, 1971), p.10.

Therefore, those children who were originally able to decenter and who were later determined to be unable to decenter can be interpreted as being in transition from one developmental stage to the next. This suggests that the tests used were not sensitive enough to detect the exact developmental stage the children were at originally.

Only through observation of everyday activities of the subjects was it possible to identify their manipulation and exploration of the Logo environment. Awareness of the sensitivities some of the children felt towards the computers, such as S3. and his concern for the well being of the plants and the computers, could not have been quantitatively stated. The vast imaginations observed by the researcher of the children who 'played' with the computers without using available software and the Logo language would also have gone unrecorded using quantative measures alone. It is apparent observational measures provided valuable insights into the process young children go through in developing higher cognitive abilities, especially that of decentering. In researching young children's cognitive development within a Logo environment, a combination of quantitative and qualitative measures is most effective.

Research Recommendations

This study suggests the need for research into the area of cognitive development and its possible relationship to the Logo language. A longitudinal study encompassing at least a two to three year time period should be undertaken. The suggested experimental design is as follows:

-subjects using Logo in an unstructured environment.

-subjects using Logo in a structured environment.

-subjects using C.A.I. in an unstructured environment.

-subjects using C.A.I. in a structured environment.

-subjects in a non-computerized structured environment.

-subjects in a non-computerized unstructured environment.

The variables under investigation would be structured environment versus an unstructured environment, Logo versus C.A.I., Logo versus no computer influences, and C.A.I. versus no computer influences. Piagetian tests should be the basis for the measurement but their non-parametric nature limits their interpretation to ordinal scales. Piagetian tests should be supported by observational study when researching Piagetian concepts of cognitive development. Elkind (1971) states "In the case of Piagetian tasks, therefore, their justification lay in whether or not they revealed developmental trends in the kinds of concepts about which Piaget was concerned." (p.26)

This study has examined Papert's claims that Logo does help young children develop higher cognitive abilities. The statistical evidence does not validate such claims but they do support Piagetian theory regarding developmental levels with reference to age and experiential factors. Observational data have introduced additional variables unrecognized by the researcher at the start of the study. It is suggested that further studies in the area of Logo and young children focus on these variables using both quantative and qualitative measures. In addition, the data from this thesis research suggest the use of computer games enhances young children's cognitive abilities.

As it is a well known Piagetian statement that young children do indeed learn through play, further research into the possible effects of computer games on the young child's physical and cognitive environment is recommended. Through a combination of data collection techniques, educators will understand better how children interact with and use a computer language and high technology environment in a way best suited to their individual learning styles.

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APPENDIX A

Table A

We, the undersigned, agree to abide by the ethical guidelines for human research adopted by the Board of Governors of the University of Manitoba and to carry out this project as described on this Ethics Review Form.

Principle Investigator

Faculty Supervisor *(if student research)

* - All student projects must be supervised by a faculty member.

* - In the case of research courses, it is the obligation of the supervisor to ensure that ethical approval has been obtained.

- -

For Ethics Committee Use:

Approved:

Date: March 20, 198-

Table B

UNIVERSITY OF MANITOBA FACULTY OF EDUCATION Winnipeg, Manitoba
Canada R3T 2N2

January, 1984

Dear Parents,

I would like to request your permission in allowing your child to participate in a Master's thesis research project, the title of which is: COMPUTERS IN THE PRESCHOOL: A STUDY OF PIAGETIAN CONCEPTS, COMPUTER ASSISTED INSTRUCTION, AND SEX DIFFERENCES.

Microcomputers have become an integral part of the Ed. Psyc. preschool setting since January 1983. My thesis involves researching the effects, if any, that various computer experiences have on a young child's cognitive development. As well, the area of sex-difference in learning related to microcomputers will be examined.

The study will involve giving each child both a pre and a post Piagetian test on preoperational and concrete operational tasks. They will then be free to play with the various computer programs available. It will be up to the child to make a decision as to whether or not he/she should interact with the microcomputer on any particular day.

Confidentiality of all preschool students involved will be maintained throughout the entire study and no student will be forced to participate beyond his/her interest level in the project.

If you wish to observe the project feel free to do so at anytime.

I would be happy to answer any questions you may have concerning this project or to discuss it in further depth.

I thank you in advance for your reply and consideration.

Shelley D. Turnbull

Shelley D. Turnbull

office # 474-9629

I ---------------------------------- give my permission for ------------------------ to participate in the research of S. Turnbull's Master's Thesis on computers in the preschool.

Table C

Piagetian Interview Form

f Child

iewer

	Achievement	Comments
versability		
nsformation		
ssification Test A		
ssification Test B		
nservation of Liquid		
nservation of		

APPENDIX B

FIGURE FIVE

RAW TEST SCORES

EXPERIMENTAL GROUP ONE

SUBJECT	PRE1	POST1	PRE2	POST2	PRE3	POST3	PRE4	POST4	PRE5	POST5
1	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.5	0.0
2	0.0	0.0	0.0	0.0	0.5	1.0	0.0	0.5	0.0	0.0
3	0.0	0.0	0.0	0.5	1.0	1.0	0.0	0.0	0.0	0.5
4	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.5	0.5	0.0
5	0.0	0.0	0.0	0.0	0.5	1.0	0.5	0.5	1.0	0.0
6	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.5	1.0	1.0	1.0	0.0	0.5	0.0	0.0
8	0.0	0.0	0.0	0.0	1.0	1.0	0.5	0.0	0.0	0.0
9	0.0	1.0	1.0	1.0	1.0	1.0	0.5	0.5	0.5	0.5
10	0.0	0.0	0.5	1.0	0.0	1.0	0.0	0.5	0.0	0.0
11	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	1.0	0.0	1.0	1.0	0.5	0.5	0.0	0.0
13	0.0	0.0	0.0	0.0	1.0	1.0	0.5	0.5	0.0	0.0
14	0.0	0.0	0.0	1.0	1.0	1.0	0.5	0.5	0.0	1.0
15	0.0	0.0	0.0	0.5	1.0	1.0	0.5	1.0	0.0	0.5
16	0.0	0.0	1.0	1.0	1.0	1.0	0.5	0.0	0.0	0.0
17	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.5	0.0	0.5
18	0.0	0.0	0.0	0.5	1.0	1.0	0.0	0.5	0.0	0.0
19	0.0	0.0	1.0	1.0	1.0	1.0	0.5	0.5	0.0	0.0
20	0.0	0.0	0.0	1.0	1.0	1.0	0.5	0.0	0.0	0.0
21	0.0	0.0	1.0	0.5	1.0	1.0	0.0	0.5	0.0	0.0

FIGURE SIX

RAW TEST SCORES

EXPERIMENTAL GROUP TWO

SUBJECT	PRE1	POST1	PRE2	POST2	PRE3	POST3	PRE4	POST4	PRE5	POST5
22	0.5	0.5	0.0	0.5	0.0	0.5	0.0	0.5	1.0	0.0
23	0.5	0.0	0.5	1.0	1.0	1.0	0.0	0.5	0.0	0.0
24	0.0	0.0	0.0	0.0	0.5	1.0	0.5	1.0	0.0	1.0
25	0.0	0.0	0.5	0.5	0.5	1.0	0.0	0.5	1.0	1.0
26	0.0	0.0	0.0	0.5	0.0	1.0	0.0	0.5	0.0	0.0
27	1.0	1.0	0.5	1.0	0.0	0.5	0.0	0.5	0.5	0.5
28	0.0	0.0	1.0	0.5	1.0	1.0	0.5	0.5	0.0	0.0
29	0.0	0.0	0.0	0.5	1.0	1.0	1.0	1.0	0.0	0.0
30	0.0	0.5	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.5
31	0.0	0.0	1.0	0.0	0.0	1.0	0.0	0.5	0.0	0.5
32	0.0	0.5	1.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
33	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.5	0.0	0.0
34	0.0	0.5	0.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0
35	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.5	0.0	0.0
36	0.0	1.0	0.0	1.0	1.0	1.0	0.5	1.0	0.0	1.0
37	0.0	0.0	0.0	0.5	1.0	1.0	0.5	1.0	0.0	0.0
38	0.0	0.0	1.0	0.5	1.0	1.0	0.5	0.0	0.0	0.0
39	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.5	0.0	0.0
40	0.5	1.0	0.0	0.0	1.0	1.0	0.0	0.5	0.0	0.5
41	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.5	0.0	0.0
42	0.0	0.0	1.0	1.0	1.0	1.0	1.0	0.5	0.0	0.5
43	0.0	0.0	0.0	1.0	1.0	1.0	0.5	0.0	0.0	0.0
44	0.0	1.0	0.0	0.5	1.0	1.0	0.5	0.5	0.0	0.0
45	0.0	0.0	0.5	0.5	1.0	1.0	0.0	0.5	0.0	1.0
46	0.0	0.0	1.0	1.0	1.0	1.0	0.5	0.5	0.0	0.0

Figure Seven

EXPERIMENTAL GROUP 1
STANDARD MEANS

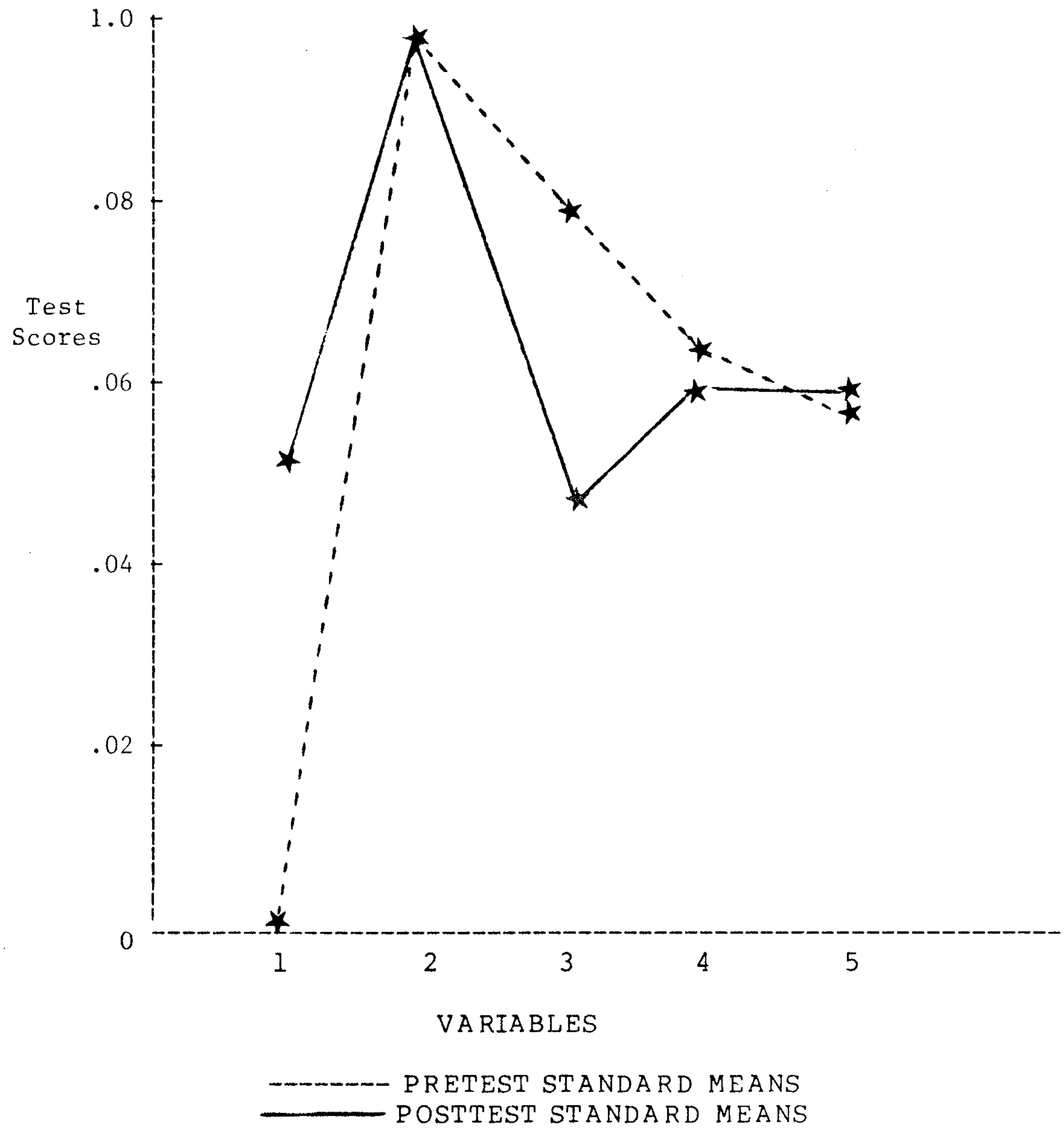


Figure Eight

EXPERIMENTAL GROUP 2

STANDARD MEANS

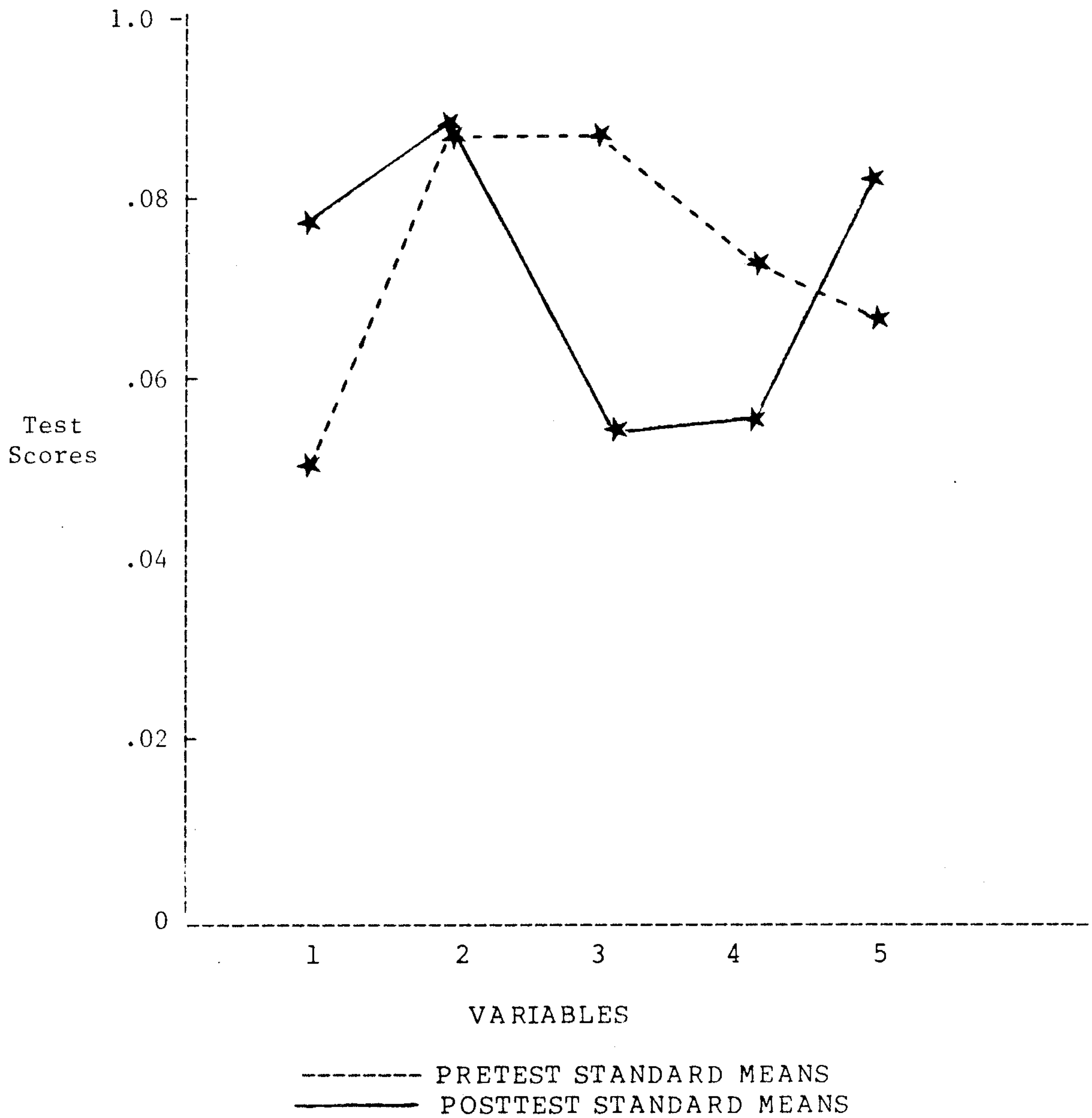


Figure Nine
STANDARD MEANS
OF THE DIFFERENCES BETWEEN PRE AND POST TEST SCORES

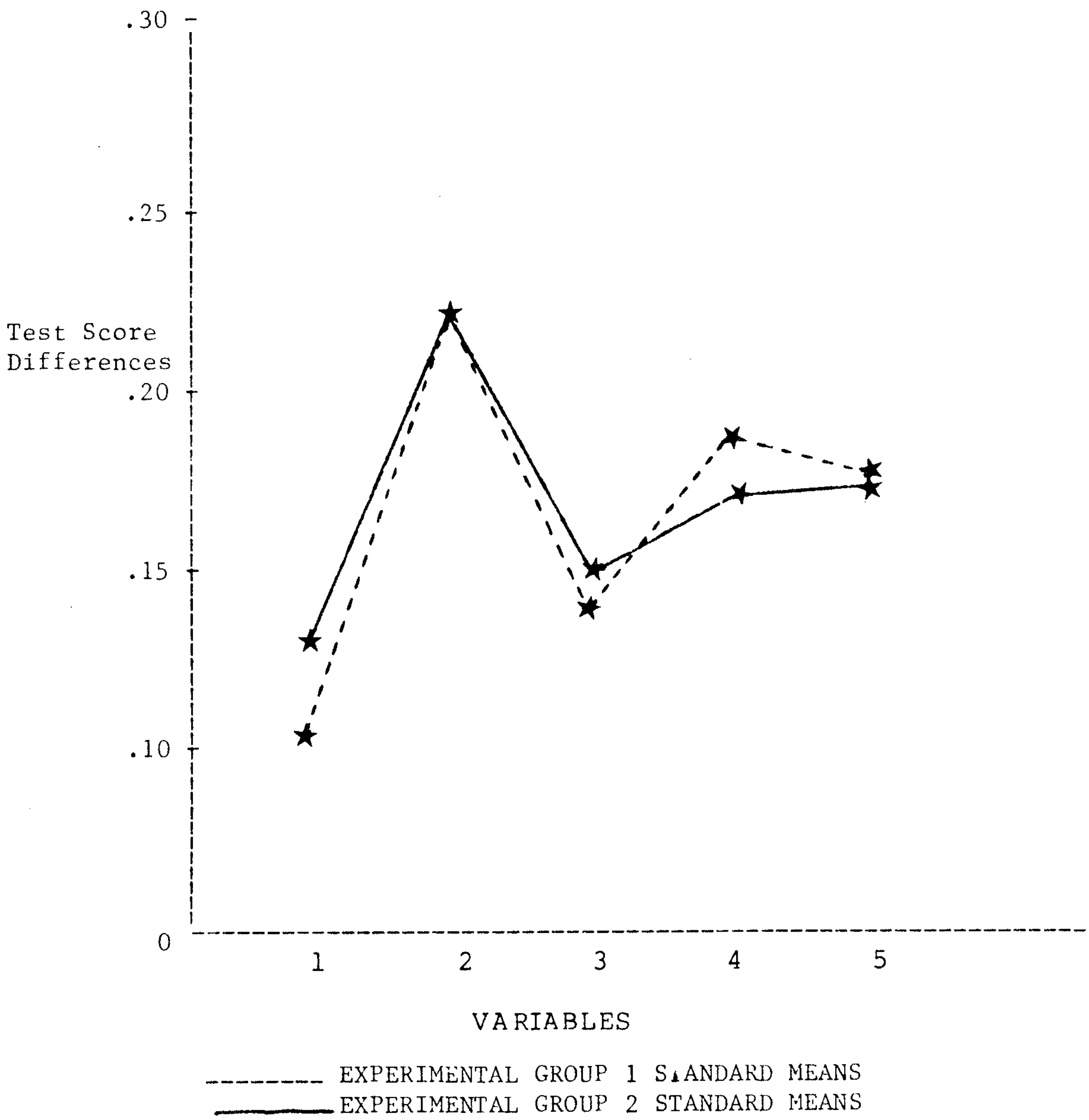


Figure Ten

EXPERIMENTAL GROUP 1
AVERAGE STANDARD DEVIATIONS

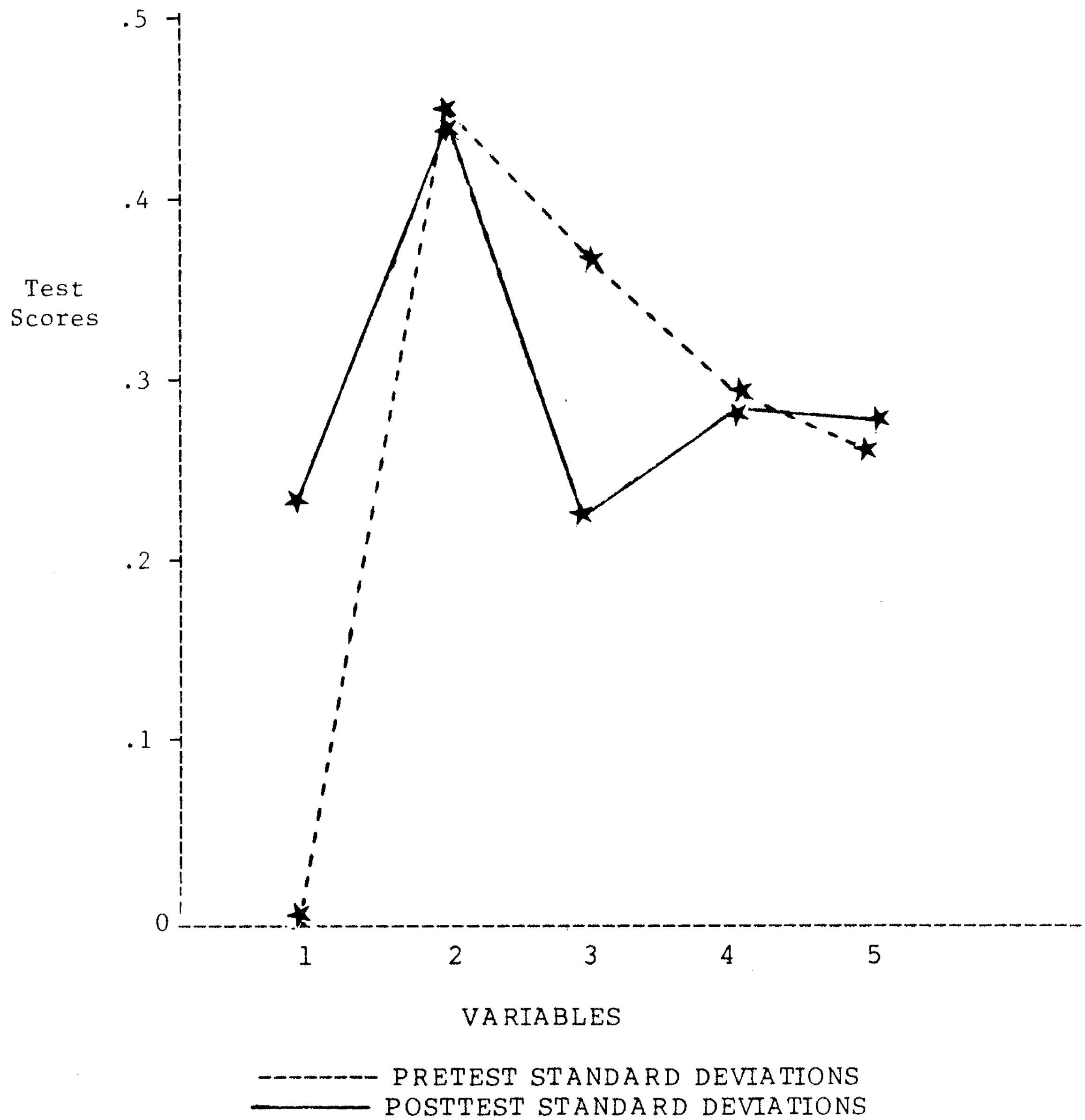


Figure Eleven

EXPERIMENTAL GROUP 2

AVERAGE STANDARD DEVIATIONS

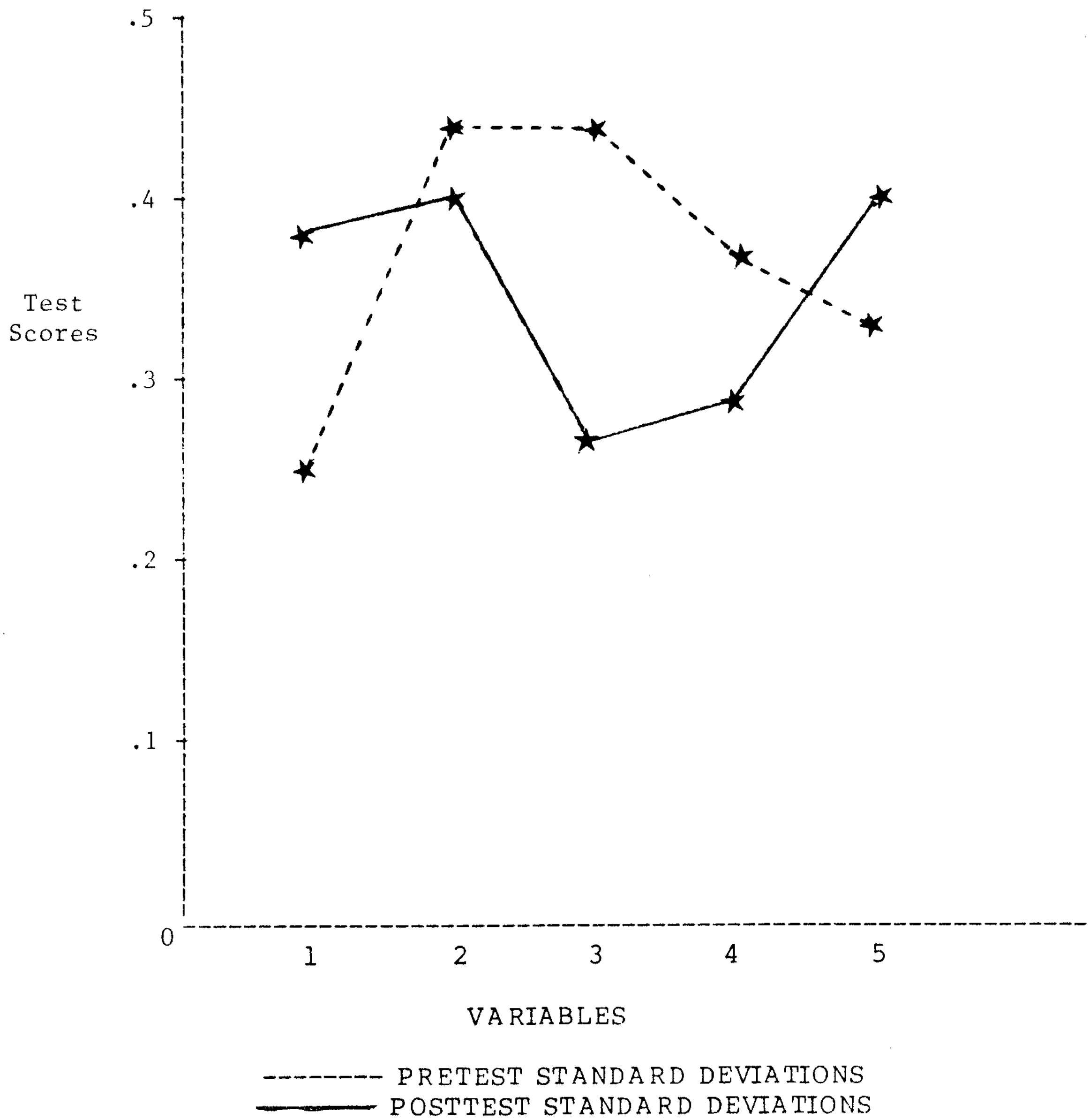
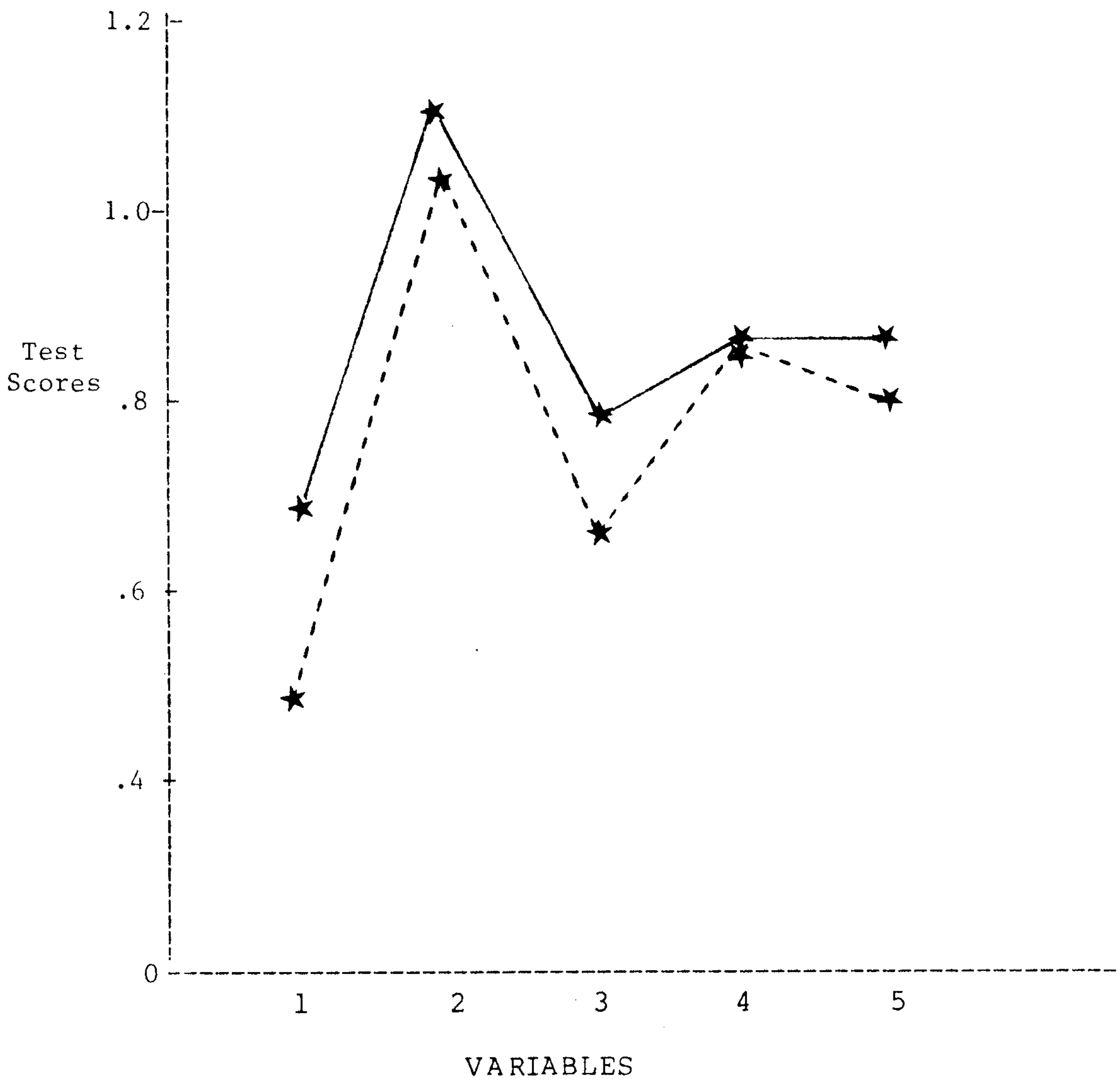


Figure Twelve
STANDARD DEVIATIONS
OF THE DIFFERENCES BETWEEN PRE AND POST TEST SCORES



-------- EXPERIMENTAL GROUP 1 STANDARD DEVIATIONS
———— EXPERIMENTAL GROUP 2 STANDARD DEVIATIONS

Figure Thirteen
FREQUENCY POLYGON REPRESENTING
THE DIFFERENCES BETWEEN PRE AND POST TEST SCORES
FOR BOTH EXPERIMENTAL GROUPS ON REVERSABILITY

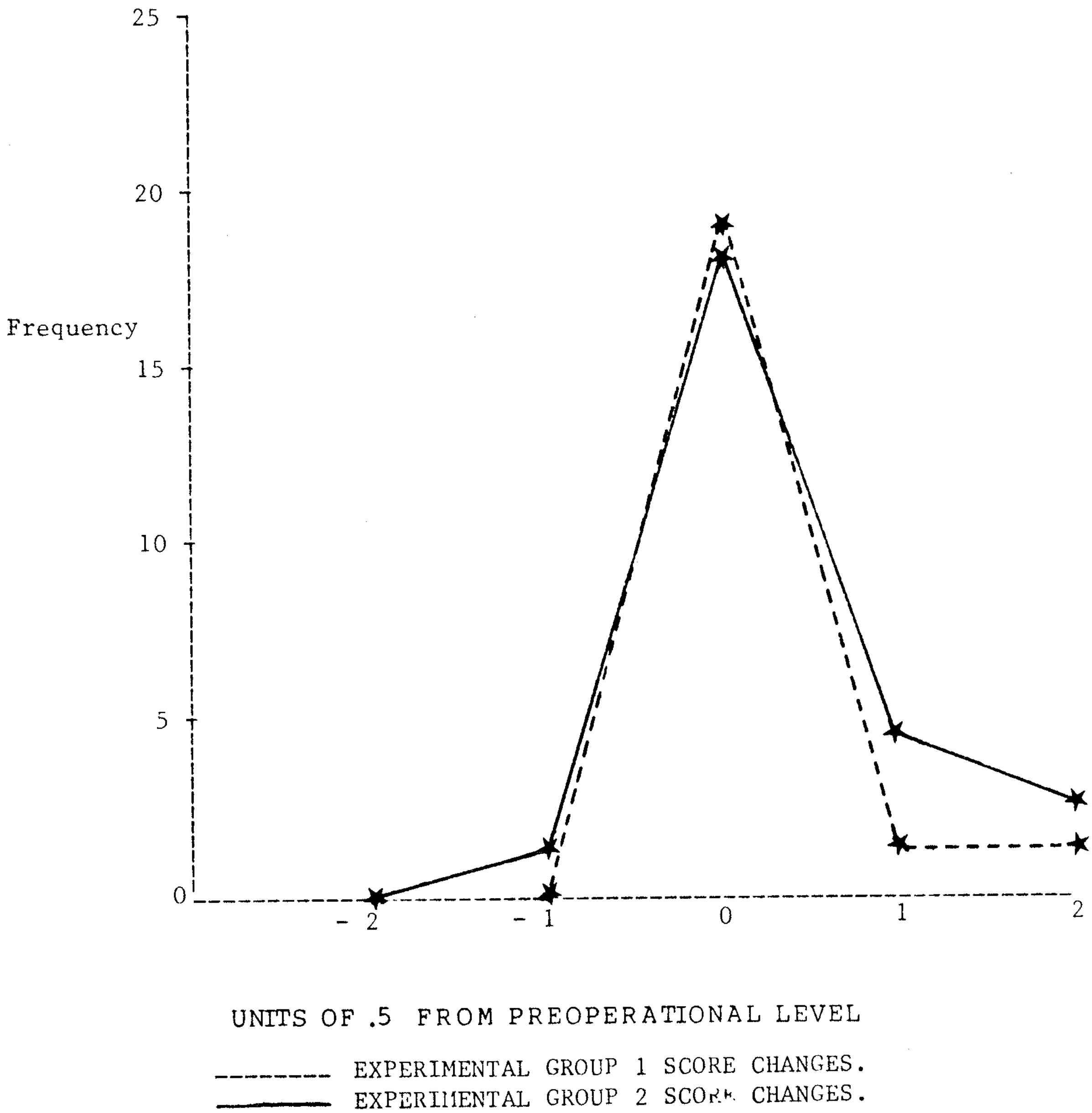


Figure Fourteen
FREQUENCY POLYGON REPRESENTING
THE DIFFERENCES BETWEEN PRE AND POST TEST SCORES
FOR BOTH EXPERIMENTAL GROUPS ON TRANSFORMATION

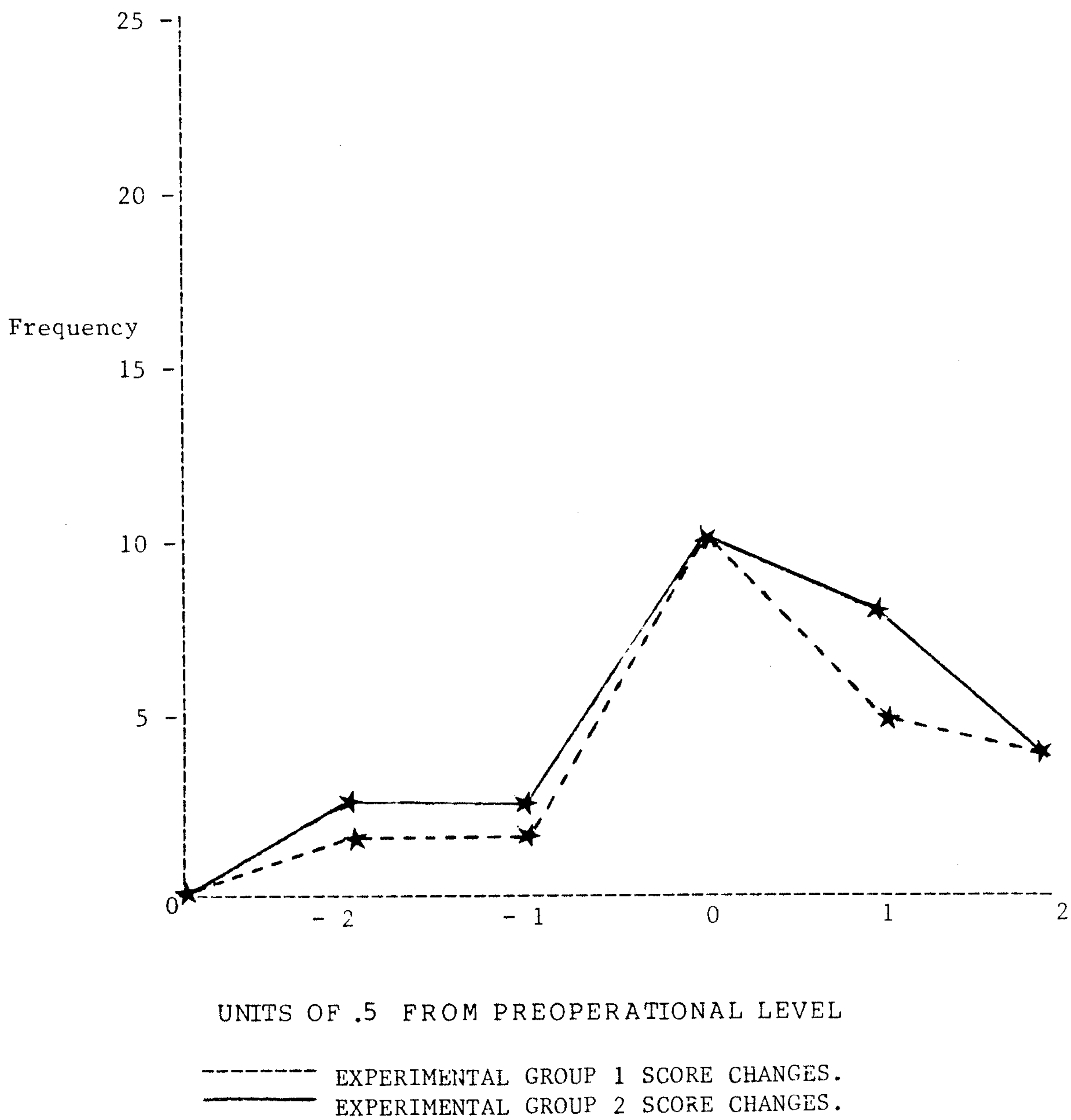


Figure Fifteen
FREQUENCY POLYGON REPRESENTING
THE DIFFERENCES BETWEEN PRE AND POST TEST SCORES
FOR BOTH EXPERIMENTAL GROUPS ON CLASSIFICATION A

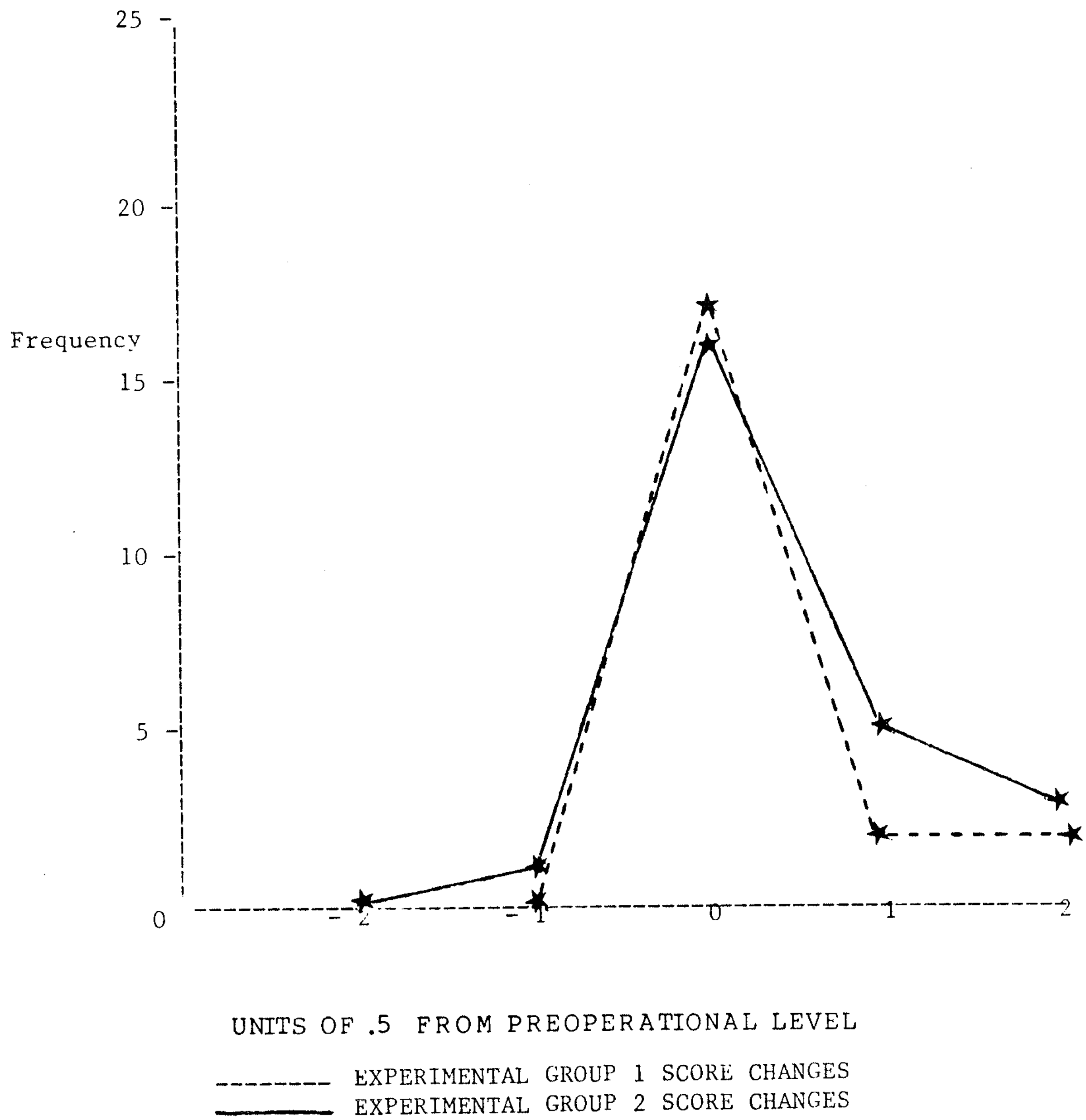


Figure Sixteen
FREQUENCY POLYGON REPRESENTING
THE DIFFERENCES BETWEEN PRE AND POST TEST SCORES
FOR BOTH EXPERIMENTAL GROUPS ON CLASSIFICATION B

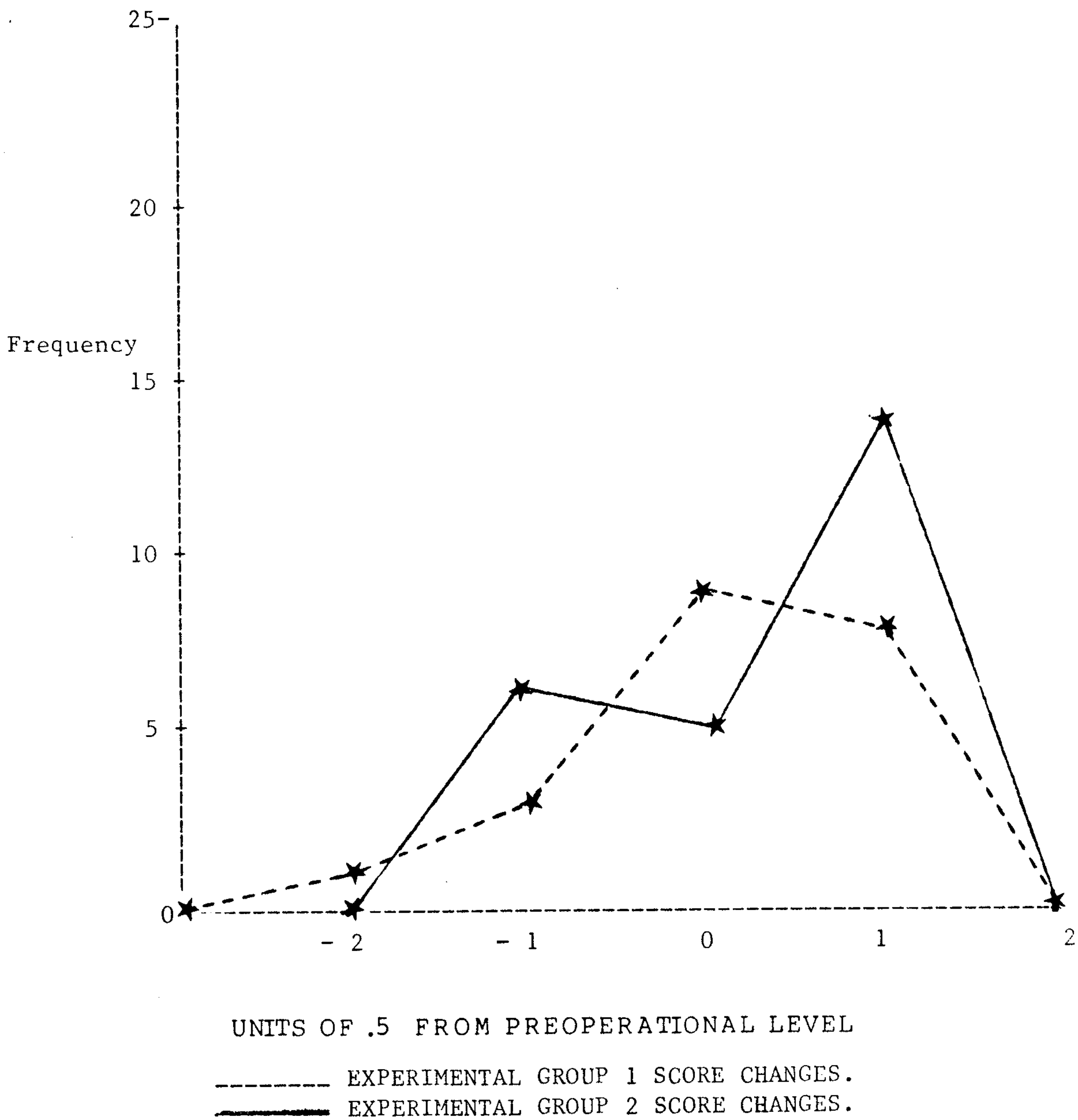


Figure Seventeen

FREQUENCY POLYGON REPRESENTING
THE DIFFERENCES BETWEEN PRE AND POST TEST SCORES
FOR BOTH EXPERIMENTAL GROUPS ON <u>CONSERVATION</u>

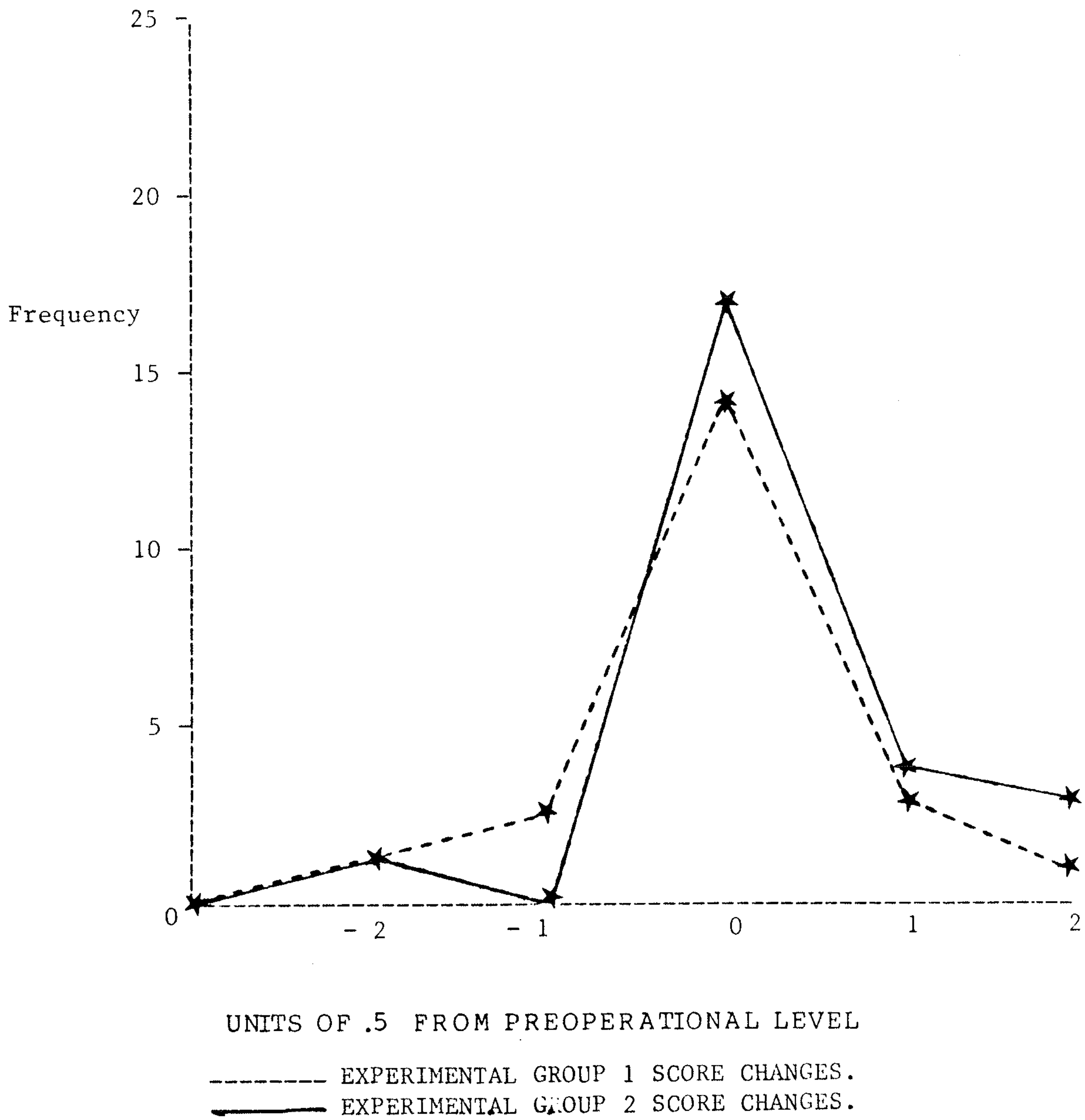


Figure Eighteen

ANALYSIS OF VARIANCE SUMMARY TABLE

VARIABLE #1

REVERSABILITY

SOURCE OF VARIANCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE
BETWEEN	0.32431677	1	0.32431677	3.03
WITHIN	4.70285714	44	0.10688312	
TOTAL	5.02717391	45		

A value of F(4.06) is required for significance at the .05 level

Figure Nineteen

ANALYSIS OF VARIANCE SUMMARY TABLE

VARIABLE #2

TRANSFORMATION

SOURCE OF VARIANCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE
BETWEEN	0.05822981	1	0.05822981	0.31
WITHIN	8.14285714	44	0.18506494	
TOTAL	8.20108696	45		

A value of F(4.06) is required for significance at the .05 level

Figure Twenty

ANALYSIS OF VARIANCE SUMMARY TABLE

VARIABLE #3

CLASSIFICATION A

SOURCE OF VARIANCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE
BETWEEN	0.05979296	1	0.05979296	1.01
WITHIN	2.59238095	44	0.05891775	
TOTAL	2.65217391	45		

A value of F(4.06) is required for significance at the .05 level

Figure Twenty-One

ANALYSIS OF VARIANCE SUMMARY TABLE

VARIABLE #4

CLASSIFICATION B

SOURCE OF VARIANCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE
BETWEEN	0.23291925	1	0.23291925	2.87
WITHIN	3.57142857	44	0.08116883	
TOTAL	3.80434783	45		

A value of F(4.06) is required for significance at the .05 level

Figure Twenty-Two

ANALYSIS OF VARIANCE SUMMARY TABLE

VARIABLE #5

CONSERVATION

SOURCE OF VARIANCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE
BETWEEN	0.28183230	1	0.28183230	2.23
WITHIN	5.57142857	44	0.12662338	
TOTAL	5.85326087	45		

A value of F(4.06) is required for significance at the .05 level