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IN MOTHER´S LAP: MICROCOMPUTERS, MOTHER´S TEACHING BEHAVIOR AND YOUNG CHILDREN`S CLASSIFICATION SKILLS

by

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APPROVAL PAGE

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Forty-one preschool children enrolled in a southeastern university enrichment program, 21 2-year-olds and 20 3-year-olds, were randomly assigned to two treatment groups: a microworld computer experience designed to teach the concept inside/outside and an ABC computer experience designed to drill the alphabet. Mothers assisted children in gaining computer competency.

Mother/child dyads were videotaped during each 15-minute session for a total of one hour of treatment. Videotapes were coded and scored using the Wood and Middleton (1975) Assisted Problem-Solving Scale with interrater reliabilities consistently over .80. Children were administered a classification task at the end of treatment.

Data analysis revealed the following: microworld mothers relinquished control of software to children as competency developed; depending on the type of software, different mother intervention strategies were used; age of child influenced intervention strategies; and finally, mothers in both groups emerged capable of teaching their children to use computer software with minimal training. A 2x2 ANOVA yielded no significant main effects for group or age on the classification test. However, the age*group interaction approached significance with 3-year-olds in the microworld group classifying somewhat better. A repeated-measures, mixed-model ANOVA revealed a highly significant within-groups effect for age on number of classifications per day. Three-year-olds within the microworld group

were significantly more successful than 2-year-olds on object classification.

It was concluded that mothers can teach their children to use complex software with minimal training. Furthermore, software differences had a significant influence on the form and content of dyad interaction. Finally, 3-year-olds seemed to be ready to deal with microworld software as evidenced by their development of advanced classification skills.

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TABLE OF CONTENTS

Page

CHAPTER

LIST OF TABLES

CHAPTER I

BACKGROUND

Computers and education are terms that are used in conjunction with increasing frequency. One hardly picks up a newspaper or magazine without finding some reference to computers and how they are changing the face of education at school and at home. One recent reference to computers (Dusewicz, 1981) predicted that microcomputers will soon replace pencil and paper as principal student learning tools.

It is interesting to note that the speed with which computers have become headlines has been phenomenal. This lightning-fast rise to headline status has not been nearly so swift as the introduction of computers into schools. The results of a recent survey of public schools in America reveals a 56 percent increase in one year (Study Finds, 1982). The fastest growth of computer use within this survey was witnessed by an 80 percent increase in elementary schools. Furthermore, it has been shown (Wrege & Watt, 1982) that the use of computers in education has moved from graduate research in the 60's to high schools and junior highs in the 70's and finally into the elementary schools and preschools in the 80's. It is important to note that this movement, unlike the "new math", has had a grass roots foundation (Shade & Nida, 1983). It has been parents rather than educators who have pushed for computers in their children's schools, from college to nursery. The subtle fervor with which parents are pushing computers can be witnessed in the educational computer software market. In 1982 sales of educational software for the home increased 71 percent from the previous year, making educational home software the fastest growing segment of that market (Bell, 1983; Dickson, 1983).

Regardless of who or what lies behind the rise of computers from obscure, exotic data managers to a must for every home and school, the computer has brought with it a number of important issues. Pros and cons abound on every side and often the camp getting the most attention is the one yelling the loudest. A few examples of these issues follow.

First, the computer has been predicted to have an influence on our lives as great or greater than the Gutenberg printing press or Sputnik (Zinn, 1982). Along these lines, Heller and Martin (1982) proclaim that "we are now on the brink of a computer impact in the field of education so great that . . . it will have an impact of equal or greater magnitude upon man's intellectual development as that of reading and writing." This is certainly the philosophy of the many computer schools for young children that have sprung up all over the nation. One example of this is the Palos Verdes Learning Center in Palos Verdes, California. This particular school has a computer class for infants and mothers called "Mommy and Me" (Langway, Jackson, Zabrarsky, Shirley, & Whitmore, 1983). However, Wartella and Reeves (1982) have warned that "no media revolution of the past has fulfilled the promises of its proponents concerning its educational potential." Furthermore, Kelman (1982) counters that the computer revolution has been so swift that no time has been taken to "reflect seriously upon the pedagogical, psychological, philosophical, and ethical issues involved in computer-based education."

Recently, Barnes and Hill (1983) took time to reflect on some of these issues and warned that young children should not work with computers because of insufficient cognitive development necessary to benefit from such interaction as well as the fear of social isolation. Others have also predicted that as a result of early interaction with microcomputers, which they assume to be an isolating experience, children "will become single-minded automatons or technokids bereft of human feeling (Stout, 1983)." This would result, according to Tittnich and Brown (1981), from the removal of the teacher from personal, intimate involvement with the child.

Statement of the Problem

In light of the present controversy over the computer's monster/messiah split personality (Shepard, 1980) and the constant pressure to interface children with computers at ever younger ages, this study was undertaken. Specifically, it was intended to investigate several claims which have been made in the computer debate but which have little empirical backing. For example, can a child (age 20 months to 36 months) learn to work with a microcomputer? Can a mother, with the aid of age-appropriate software, teach her child to use a microcomputer with only minimal training? How does a mother go about teaching her child when a microcomputer is present? Will her teaching behaviors be similar to other reported situations (Wood & Middleton, 1975; Wood, Bruner, & Ross, 1976)? And finally, is a microcomputer an effective way to teach young children classification skills?

Hypotheses and Definition of Terms

This study proposed to design a microworld in which very young children, 20 to 36 months, can exercise powerful ideas that relate to the development of concept formation and classification skills at the basic level. Papert (1980b) defines a microworld in terms of the following:

> A subset of reality or a construct of reality whose structure matches that of a given cognitive mechanism so as to provide an environment where the latter can operate effectively. The concept leads to the inventing of microworlds so structured as to allow a human learner to exercise particular powerful ideas or intellectual skills. (p. 204)

In other words, a microworld is a simulated environment where children have direct access to particular concepts and the ability to manipulate those concepts in meaningful ways. By this it is meant that children will be able to direct the appearance of objects on the screen as well as a variety of object attributes (speed, direction). Of course, when Seymour Papert speaks of microworlds, he is talking about LOGO, the turtle, and turtle-geometry. These microworld components provide an environment in which the child can exercise powerful mathematical ideas. Robert Lawler (1982a, 1982b) has extended the idea of a microworld in his own unique way. He designed a microworld called "Beachworld" in which his three-year old daughter Peggy could manipulate (through simple keyboard functions) computer graphics (car, sun, ball) that corresponded to 20 different words (Lawler, 1982b). Peggy would type in the word ′sun′ from a 3x5 card and instantly a graphic sun would appear in the clouds above the beach scene. At first she did not know what the words meant and only knew a few letters; however, in three months Peggy had learned to read those 20 words she had been manipulating and exercising. Furthermore, when tested by picking the same words off a printed page, Peggy could still read them and relate what they meant. Lawler (1982b) concluded her learning had generalized.

The significance of the microworld to early childhood education has been emphasized by Papert (1980a). Speaking of concept formations Papert suggested that in the past a child had to rely on his experience to learn about a particular concept, for example, four-legged animals. In order to tell a cow from a dog children must experience the objects and assimilate and accomodate them into their schemes. Papert stated that such concept learning can be greatly accelerated by the microworld. Imagine how fast children might learn to correctly categorize four-legged animals when examples of every kind are at their fingertips. In other words, experiences that might take months or years could be greatly compressed. This is what Papert meant when he spoke of a culture rich in the building blocks of intellectual development.

Using a microworld such as explained above, the following hypotheses have been proposed:

1a. By the end of a one-hour intervention, children will be operating software by themselves as indicated by mothers' use of lower levels of intervention.

1b. Level three, Mother Demonstrates, will allow the least child success (hardest) followed by level two, level one, and no intervention.

2. A mother will adjust her level of intervention as a result of feedback from her child and not because of some intrinsic teaching style.

3. A mother who is more sensitive to her child's abilities and developmental level will be more successful in teaching her child to use the microcomputer than a mother who is not.

4a. A child who spends one hour working with a microworld while sitting in mother's lap will be able to correctly categorize a series of objects as belonging inside-a-house or outside-a-house.

4b. Children in the 2-year old group will perform as well on the posttest as children in the 3-year-old group.

5. It will take a minimum of three days for the 3-year-olds and four days for the 2-year-olds to learn the concept.

The following definitions will be used consistently throughout this paper:

1. Operation of Software: Software operation has been simplified in consideration of subjects' ages. Children will not be required to learn sophisticated software commands but simply which buttons to push for desired results.

2. Age-appropriate Software: Simplified software that requires skills a child already possesses or can easily master, for example, one-digit key punching.

CHAPTER II

REVIEW OF THE LITERATURE

Throughout history new methods of processing and communicating information have dramatically enlarged the scope of human knowledge and radically changed how people think (Evans, 1980). For example, as writing skills developed, people were freed from the burden of rote memorization and the amount of information available to people was vastly multiplied. The invention of the Gutenberg printing press in 1450 provided the masses with access to ideas and thoughts that had previously been available only to aristocrats and clergy. Film, radio, television, and tape have all played roles in the present information revolution with their own contributions to education (Wartella & Reeves, 1982). Now the computer is here with its ability to store vast amounts of information that spills forth at the speed of light greatly amplifying people's minds. How will our thinking be changed as a result of this amplification? No one knows at the present time, but speculations abound. For example, there are those who see the computer as a means of allowing children to develop an intimate contact with their own thinking such as has never been possible before (Lawler, 1982; Papert, 1980a). On the other hand, there are those who warn against such early contact with computers. At worst, these individuals fear the creation of a race of people who have lost their humanity (Stout, 1983). At the very least, they are concerned that rather than enhance development the computer might actually harm development as other essential activities are displaced (Barnes & Hill, 1983; Brady & Hill, 1984). These concerns and others have been noted to recur with the availability of any new technology or educational media (Wartella & Reeves, 1982). It is not unusual to hear the microcomputer spoken of in terms of the following issues: Do our children attend to this media? How much do they attend? What other activities are displaced? Is the medium harmful to their health perhaps causing radiation, or eye strain? How will their values, attitudes and behaviors be affected (Wartella & Reeves, 1982)? Other general questions involving computers and children are less recurring and more unique to the nature of the technology itself. Can young children, who cannot read or write, even use a microcomputer (Barnes & Hill, 1983)? Assuming they could manipulate the machine to an effective degree, what then is to be gained from such intervention (Brady & Hill, 1984)? The answers to such questions are far from being answered as research investigations have been few and mostly of an anecdotal, observational nature (Brady & Hill, 1984). Yet, across the country, nursery schools (Stout, 1983) and special "superbaby" institutions (Langway, Jackson, Zabrarsky, Shirley, & Whitmore, 1983) are interfacing preschool children with microcomputers and promising a wide range of benefits from increased intellectual development to future job security. Are such promises foolhardy or are these basic assumptions realistic? After all, Wartella and Reeves (1982) have noted that no medium has ever fulfilled the educational potential proclaimed by its supporters. What then should be made of the recent emphasis on computer intervention for young children? As Dickson (1983) has pointed out, it is already too late to answer this question.

He stated that with more than seven million new computers moving into homes over the next year, many are already in the hands of young children. So the question is how best to work with young children at the computer.

Young Children and Computers

In spite of the observational, anecdotal nature of much of the curent research involving children and microcomputers (Brady & Hill, 1984), enough replications have occurred to draw conclusions about the appropriateness of interfacing young children with microcomputers. For example, it has been well established that preschoolers can indeed work with the standard keyboard and other parts of the computer configuration (Borgh & Dickson, 1983; Muller, 1983; Rosen, 1982; Shade, Daniel, Nida, Lipinski, & Watson, 1984; Swigger & Campbell, 1981; Watt, 1982). Preschool children, ages 3 through 5, have been observed to perform the following with minimal teaching or teacher supervision: turn the machine on and off, remove and replace diskettes properly, follow the instructions of a 4-choice picture menu, and change programs (disks) as often as three times in a 10-minute period. Furthermore, children in these settings, nearly all university preschool laboratories, have been observed to work together at the computer with minimal supervision. Several of these studies have found that preschool children prefer to work at the computer together in naturally occuring dyads and triads and spend a great deal of their time talking about the computer and related topics. Microcomputer interactions with young children have also been observed to involve a great deal of turn-taking, sharing, and other positive social interactions such as helping one another (Borgh & Dickson, 1982; Muller, 1983; Shade et al. 1984).

Limited work has been done in this particular area with children under the age of 3. However, Dickson (1983) has observed that 2-year-olds should be able to work with a standard keyboard because of their ability to pick up tiny objects such as raisins and to push things. Dickson noted that first 2-year-olds push a key and see something happen, they then learn to discriminate, and then to make choices. Dickson (Reed, 1983) supported this claim with observations of his own son, Josh (then 2). Josh knew the names of various keys and discriminated between them. He could open and close the disk drive door, turn the machine on and off, and select what he wanted to do from a menu by pressing the appropriate keys. Furthermore, diRenzo (1983) found that children as young as 18 months old can master a variety of similar computer-related skills in as little as five 30-minute sessions.

It can be seen from the above that, contrary to premature warnings (Barnes & Hill, 1983), the microcomputer is indeed accessible to very young children. It is necessary to point out that what makes the computer accessible is the particular software causing it to function. Age-appropriate software can be defined as software that allows a very young child to interact with a microcomputer without the need for reading or other skills. In other words, the child can rely heavily on the skills already possessed such as key stroking. Usually software appropriate for the preschool age child merely requires the punching of a few particular keys to cause the computer to respond.

It has also been shown that the microcomputer often serves as a social facilitator in the preschool classroom (Borgh & Dickson, 1983; Church & Wright, 1983; Jewson & Pea, 1982; Muller, 1983; Nida, Shade, Lipinski, & Watson, 1984; Sheingold, 1983). Borgh and Dickson (1983) found considerable verbal interaction occurring when preschoolers were given access to a microcomputer with age-appropriate software. Specifically, the children's verbal interactions involved turn-taking and teaching one another how to do something on the computer. Preliminary reports from the Lamplighter School Project in Dallas, Texas also observed children teaching and helping one another (Gorman, 1982; Watt, 1982). Increased social interaction has been replicated for the preschool age child (Church & Wright, 1983; Muller, 1983; Shade et al., 1984). Muller (1983) found that preschoolers spontaneously shared the microcomputer and helped each other. Their helping behaviors were primarily in the form of verbal instructions to the other child. Muller (1983) and Nida et al. (1984) both found that the presence of a microcomputer in a preschool classroom did not disrupt normal social interaction in other parts of the classroom. No studies to date have reported the effect of microcomputers on the social interactions of children younger than 3.

Young Children, Computers, and Cognitive Development

In terms of the cognitive benefits to young children, again very little research has been done. It has been observed, however, that preschool children can learn a great deal about microcomputer configuration with very little structured teaching (Shade et al., 1984). Two groups of preschool children (3 to 5 years) were studied. The first group came from a half-day nursery school setting and the other group was from a full-day education center. After three weeks of exposure to a microcomputer, with the final week consisting of spontaneous teacher intervention, it was observed that preschoolers gathered much information about the computer system. Specifically, they were highly successful in pointing to various parts of the computer when the interviewer named them. Children were able to correctly answer questions about the function of computer parts such as the disk drives, origin and abilities of the graphic characters, how one causes the graphics to appear, what computers are for, and the differences between computers and television.

In spite of the fact that little evidence exists to show whether microcomputers do or do not benefit children cognitively, several educators have strongly voiced their negative thoughts on the matter (Barnes & Hill, 1983; Brady & Hill, 1984). Criticism of young children's use of microcomputers centers around several issues. First, that the preschool child, being in the preoperational stage of cognitive development, cannot deal with the abstractions presented by the computer screen, i.e., graphics. Second, the preoperational child needs to experience real objects in the real world. Third, the assumption is often erroneously made that when a child works with a microcomputer it is done in isolation. Therefore, the preschool child would suffer in his or her language, social, and emotional development. To sum it up, Barnes and Hill affirm that preoperational children "do not understand the significance of their interactions with computers (p. 53)." Vygotsky (1978) would say these researchers are operating on a false assumption; that education should not be aimed at the level of mental development currently occupied by the child. Such short-sighted goals orient "learning towards yesterday's development."

Given the current lack of empirical evidence, it is incorrect to assume the preoperational child incapable of any of the "concrete operational" tasks thought necessary to benefit from computer interactions. Although activities appropriate for young children and microcomputers would naturally be limited, they might very well be of value as methods of presenting new information and reinforcing previous learning.

Young Children and Preoperational Development

It has long been thought that children develop cognitively through a series of stages from sensorimotor development to formal operations (Piaget, 1952; Piaget, 1970). As Gelman and Baillargeon (1983) have pointed out Piaget is undoubtedly the psychologist who has most contributed to our knowledge of the facts of cognitive development, yet he nevertheless maintained throughout his career that all cognition develops through four successive stages. Building on the work of Piaget, cognitive psychologists began to question the concept of stages (Flavell, 1977; Rohwer, Ammon, & Cramer, 1974). These individuals concluded that sufficient evidence existed to show that important cognitive changes are marked by a slow, gradual process rather than the abrupt changes implied by Piaget's theory. Rohwer, Ammon, and Cramer (1974) have commented, "children do not universally wake up on their seventh birthdays . . . to find that they have arrived at the period of concrete operations (p. 172)." It is far more likely for a child to exhibit behaviors from the stage s/he just completed, his/her current stage, and from the next stage. This is frequently referred to as horizontal decalage and is responsible for the "mixture of stages" one finds within and between children (Flavell, 1977; Ginsburg & Opper, 1978; Rohwer et al. 1974). As Flavell (1977) has shown, children continue to perfect the mental operation of weight conservation throughout most of middle childhood and well into adolescence.

Recently, Gelman and Baillargeon (1983) conducted an extensive review of the research related to the concept of stages. Citing numerous research studies, they concluded that preschool children are not nearly so egocentric as to believe others see whatever they see, are able to recognize how an object or scene appears to another person (by age two), are not so perceptually bound as predicted, and are often able to detect reciprocal transformations (conserve). Gelman and Baillargeon concluded that:

> The general implication of these studies is that the mentality of the preschool child is qualitatively more similar to that of the older child than Piagetian theory leads one to suspect. (p. 174)

Classification

Of the several domains of cognitive development, classification was chosen as the vehicle for demonstrating the concept of preoperational (and younger) children having the capacity to think enough like concrete operational children to benefit from computer interactions.

Inhelder and Piaget (1964) stated that classification begins when children group together objects that are similar in some way. However, they are not willing to credit a child with the ability to classify unless certain criteria are met. Gelman and Baillargeon (1983) elaborated on this and concluded that true classification requires the active construction of classificatory systems. In other words, the child must be able to abstract from his or her actions the essential criteria necessary for the classification. Inhelder and Piaget termed this a "turning around" on the actions of grouping and re-grouping. In their investigations of classification with over 2,000 children, Inhelder and Piaget (1964) discovered two major phases in the development of classification: graphic and nongraphic. The graphic phase, from 2 to 5.5 years, involves children's classifications on more configurational variables than similarity. Children in this age group were thought to be confused by the spatial arrangement of the objects or by descriptive properties (Gelman & Baillargeon, 1983). Because of this it was predicted that the child would err in classification tasks. In the nongraphic phase, 5.5 to 7 years, the child is no longer fooled by spatial properties and can classify on the basis of similarity alone. Of course the development of classification skills improves during this phase but the point of real concern here is that the preoperational child is considered by Inhelder and Piaget (1964) to be incapable of true classification.

A good deal of recent research has shown that young children can indeed classify objects taxonomically (Fischer & Roberts, 1980; Mervis & Crisafi, 1982; Nelson, 1973; Ricciuti, 1965; Rosch, Mervis, Gay, Boyes-Braem, & Johnson, 1976; Ross, 1980; Stott, 1961; Sugarman, 1979). Several of these studies (Mervis & Crisafe, 1982; Rosch et al. 1976; Sugarman, 1979) have shown that the young child's ability to classify depends on the level of stimuli they are shown.

Rosch et al. (1976) and Mervis and Crisafi (1982) have divided the world into three levels or categories: basic, superordinate, and subordinate. These researchers hypothesize that the basic level is the most fundamental due to its cognitive efficiency. At the basic level the similarity of members of the same category is maximized. This is due to several factors (Mervis & Mervis, 1982): First, categories at the basic level are the most differentiated from one another (chair, animal, cars); second, basic-level categories are the most general categories for which members have similar overall shapes and functions. The superordinate level is more nebulous. For example, the basic level "chair" belongs to the superordinate level category "furniture." Categorizations at the subordinate level become even more complex. A "rocking chair," "kitchen chair," and "lounge chair," are all subordinate level categories. Rosch et al. (1976) hypothesized that since children encode the world through sensorimotor activities (Piaget,

1970) or images (Bruner et al., 1966), then basic objects should be learned easily. In other words, this is the level at which humans carve up their environment and group things together. This was found to be the case as 99 percent of Rosch et al's (1976) 3-year-olds were able to sort items at the basic level. Mervis and Crisafi (1982) found this to be true for children even younger. At the basic level, all the children in their study -- 2, 4, and 5-year olds -- performed accurately when classifying. At the superordinate level only one 2-year-old, nine 4-year-olds, and all 5-year-olds could classify correctly into categories. At the subordinate level no 2-year-olds could sort the items. Similar evidence has been shown by Daehler, Lonardo, and Bukatko (1979) with 2- and 3-year-olds sorting basic-level items more accurately.

Others have contributed to this area of investigation in unique ways. The work of Fischer and Roberts (1980) is also illuminating. They presented young children with a classification task and then asked them to repeat or imitate it. The results revealed an interesting developmental trend in young children's ability to classify. For example, Fischer and Roberts found that children at the age of 15 months could sort single categories like blocks that vary along one dimension. Furthermore, 15-month-olds were able to pick circles from triangles when all were the same color and size. At 24 months children were able to handle several categories at a time (e.g., circles, triangles, and squares). Indeed, 30-month-olds were even more capable as they could sort into three categories even if variations existed within each of the categories (different types of triangles, circles, and squares). Finally, Fischer and Roberts found that 36- to 40-month-olds could even handle sorting tasks when the objects varied on both color and shape simultaneously. They concluded that children acquire classificatory skills in gradual steps which they concluded contradicted Inhelder and Piaget (1964).

Sugarman (1975, 1979) has on two occasions investigated the ontogeny of classification skills in children 3 and younger. Sugarman tested her subjects on two kinds of classificatory activities: the order in which objects were manipulated and the arrangement of objects in space. In both studies she found that at around 12 months children will repeatedly select similar objects from only one of two classes in the array. Any spatial arrangement will be haphazard at this age. At 18 months children will sequentially select one complete class of objects from the array and arrange them together in a group. The other items in the array are usually scattered about. Six months later children can sequentially select objects from both classes in the array as well as spatially arrange them in groups. By 30 months children have gained the ability not only to select and order both classes but to shift from one class to the other in the process of grouping objects. Furthermore, these children begin to show the ability to make one-to-one correspondences between dissimilar objects in the array. For example (Sugarman, 1979) children took the dolls in the array and placed them inside the rings. Thus it is seen that between the ages of 1 and 3 children begin to classify and improve rapidly in their ability to do so.

Finally, it is interesting to note the work of Nelson (1977). She presented infants (24 months) with a shoe and a cup and observed that the infants tried to put the shoe on or drink from the cup. Gelman and Baillargeon (1983) note this is an example of infants assimilating novel objects into existing sensorimotor schemas. In their terms this is a "primitive form of classification." Although evidence has been presented to show contradictions between Piagetian stage theory and current classification studies, this final bit of evidence has an uncanny agreement with an earlier statement made by Inhelder and Piaget (1964). They cited as evidence of classification the following:

> If a child enters a room with a chair in it and names it "chair", or otherwise acts in a way which implies that he recognizes that it is a chair (sitting down in it), then we . . . infer that in one sense he has classified the object as a chair. (p. xii)

<u>The Importance of Mother</u>

Mothers have been chosen to work with their children in this study for several reasons. They are the individuals to whom the children are most attached (Ainsworth, 1979), they are necessary to fulfill what Bronfenbrenner (1979) referred to as the primary context of learning, and finally Wood and Middleton (1975) have shown that mothers are the best "natural" teachers of their children.

Ainsworth (1979) emphasized the importance of the mother/child relationship when she showed that infants with a strong attachment to mother would explore a strange environment while those with less attachment would not. The importance of the mother/child relationship has been further underscored by Ladd and Mize (1983). They stated that a positive interpersonal relationship between teacher and learner "may well influence every aspect of the skill-training process (p. 153)." This is based on the assumption that children will pay closer attention when the teacher is trusted and well-liked. Bronfenbrenner (1979) has referred to this relationship as the primary-learning context. He explained:

> In this context a child is allowed to observe and engage in ongoing patterns of progressively more complex activity jointly or under the direct guidance of persons who possess knowledge and skill not yet acquired by the child and with whom the child has developed a positive emotional relationship. (p. 845)

A prime example of how effective such a learning situation can be is found in the work of Doise, Mugny, and Perret-Clermont (1975). These researchers showed that requiring a non=conserving child to work with two conserving children in what they termed a "social coordination task" resulted in significant operational advancement in thinking for the non=conserver (the child learned to conserve liquids). Non=conserving children were required to pour juice for conservers with the stipulation that equal amounts be distributed to all (glasses varied in height and width). In order to evaluate the newly gained operational thought patterns, Doise et al. retested each child. They concluded that these children were not merely parroting what had been heard in the social situation but actually attained new arguments which included the concepts of identity, compensation, and reversability. Doise et al. further concluded that "the development of ´operational thought´ can be facilitated when several individuals are required to coordinate their actions (p. 237)."

Wood and Middleton (1975) have further hypothesized that a mother, because of her general knowledge about her child, would "know" the best level at which to intervene in a teaching situation. This "region of sensitivity" was defined as the borderline area between what children are currently capable of doing and what they cannot. Vygotsky (1978) calls this the "zone of proximal development" and defines it as the distance between the actual developmental level and the level of potential development. He further refers to the zone as those functions that have not yet matured but are in the process of doing so, like buds or flowers. Vygotsky (1978) affirmed that learning aimed at developmental levels which have already been achieved is ineffective and that good learning is "that which is in advance of development (see also Ladd & Mize, 1983)." Wood and others (Wood & Middleton,1975; Wood, Bruner, & Ross, 1976) have shown that mothers and teachers of 3 to 5 year olds who concentrated their attention and activity upon the child's region of sensitivity to instruction were consequently the most effective instructors. Wood and Middleton noted:

> When a child is alone success demands that he perform all . . . operations himself. But when a mother intervenes to help him she may take over one or more of them. By doing so, she may leave the child relatively free to concentrate all his attention and effort upon a narrower range of alternatives within the task. (p. 181)

Another term for the process herein discussed is "other-regulation." Wertsch (1978), in his studies of the development of self-regulation (the ability to understand a goal, impose a strategy, and manipulate important aspects of the environment while ignoring irrelevant ones), has noted that adults typically interact with children in a way that draws attention to important aspects of the problem at hand. This interaction is what he termed "other-regulation" which takes the place of self-regulation at early ages. Wertsch stated, "the adult fulfills the role of providing information about what strategies to use, what step comes next, etc." (p. 16). A good example of other-regulation is found in the work by Mervis & Mervis (1982). They found that when mothers label objects for their preschool children they use basic-level (previously explained) words regardless of whether the child can produce the word or not. Mothers in their study labeled objects quite differently when speaking to adults.

As Wood and Middleton (1975) have also shown, other-regulation can occur at different levels. At a low level the adult may simply give the child a series of commands, while at a higher level questions aimed at revealing the strategy to the child may be included (Wertsch, 1978). It is important to point out that Wertsch (1978) along with Bronfenbrenner (1979), Vygotsky (1978), Wood and Middleton (1975), and Wood, Bruner, & Ross (1976) restrict other-regulations to a narrow range of complexity dependent upon the child's level of development. Simply stated the task can be neither too hard nor too easy. As Piaget (1952) has shown, equilibration functions most efficiently when the stimulus is only slightly incongruent with the child's present cognitive structures.

Theoretical Framework

All of the above can be integrated into the framework presented by Seymour Papert (1980a) in his book, Mindstorms, with two exceptions. He has not discussed the importance of the mother as a vehicle for enhancing young children's learning experiences and he has been primarily concerned with children learning to program. Although evidence exists to show that young children can indeed program when given help in the form of simplified hardware and software (Pearlman, 1976), this study is primarily concerned with an adaption of Papert's microworld concept as previously explained. Nevertheless, it is timely to point out several ways the above literature review can be placed within a Papertian or microworld framework.

First of all, Papert (1980a) was a student of Piaget for some time. However, he differs from Piaget in his interpretation of the prerequisites for cognitive development. Papert and Piaget agree that the child is a builder of his own intellectual structures. Papert differs from this by viewing children, like builders, as having either an abundance of or lack of sufficient materials. Our culture, Papert stated, supplies some materials in great abundance and others in relative poverty. For example, many things come in pairs (knives and forks, mothers and fathers, shoes and socks). This natural pairing of objects in the environment constitute the "materials" for learning an intuitive sense of number or basic-level classification skills. According to Papert (1980a), Piaget would explain the slower development of a particular concept by its complexity or formality, whereas Papert would say the child merely lacks the materials with which to work and build. Therefore, in Papert's terms, developmental differences can be attributed to our culture's relative poverty of materials from which "more advanced" intellectual structures can be built.

In line with Papert's (1980a) Piagetian foundations, he affirms that children ought to have "objects" with which to think. Although he is speaking specifically of the robot-turtle used with the LOGO language to teach programming, this concept can be extended to fit the computer itself. Papert outlined four conditions he affirms are necessary for objects to function as thinking devices. First, they must be part of the natural landscape. This can be taken to mean they must be accessible to the child. How software can function to make computers accessible has previously been discussed. However, computers on low tables with small chairs would be accessible. Second, these objects should be part of the adult world, the goal being to foster interaction between child and adult. It has previously been shown that computers are quickly becoming a part of everyday life as well as how they function as facilitators of social interaction. Although studies to date have predominately looked at the social interaction patterns of children, evidence exists to suggest that the microcomputer also draws children and adults together (Shade et al., 1984). During the final weeks of this study, the observer stationed near the computer became a spontaneous/interactive teacher. It was observed that such weeks were by far the most active in terms of number of children at the computer station and amount of social interaction that occurred.

Third, these objects should allow children to use their bodies with which to think. Papert (1980a) is aware of young children's level of development and their need for sensorimotor activities to bridge the gap between their present stage (sensorimotor) and budding abilities (preoperational) (see Vygotsky, 1978). Papert used the example of children "walking through" a simple program (designed to make the robot-turtle move) to discover where they have made errors. Another example of this can be found in the work previously cited by Shade et al. (1984). They observed that children often touched the screen as they counted objects or otherwise interacted with the software (often participating with the graphics, i.e., kissing characters or knocking on the door associated with the letter d). Finally, Papert stated these objects should be used to think about formal systems. In many of the studies previously cited (Borgh & Dickson, 1983; Nida et al, 1984; Pearlman, 1976; Shade et al, 1984; Swigger & Campbell, 1981; Watt, 1982) childrens's interactions with microcomputers have involved the learning of such formal systems as the alphabet, numbers and counting, spatial orientations such as up/down or right/left, and simple programming.

Conclusions and Research Predictions

It can be concluded from the above review that young preschool-aged children are capable of mastering the computer literacy skills necessary to cause the machine to function as they wish. Such skills include turning the computer off and on, changing disks, and making choices within software limitations. Microcomputers have been shown to facilitate social interaction with preschoolers helping, sharing, and teaching one another. Although little has been done to access the cognitive benefits to preschoolers, it can be concluded that the computer stimulates topic-oriented conversation and that young children can learn a great deal of information about the computer-system from minimal teacher intervention. Furthermore, preschool children have not been found to suffer from social isolation nor from a lack of other essential activities.

In terms of cognitive development and the appropriate or inappropriate nature of computer/preschool interactions, little empirical backing exists. However, it can be concluded that the claims of some are unfounded. Review of current research has shown that preschool children think more concretely than given credit for in the past. It has further been shown that with the help of significant others (mother) it may be possible to realize even greater cognitive gains for the preschooler from the microcomputer.

Based on these conclusions it was therefore predicted that preschool children who have had one hour of mother/microcomputer intervention will be able to correctly sort a series of objects as belonging inside or outside a house. Further, it was predicted that the youngest children (aged 20 to 24 months) would do as well as the older children (aged 36 to 42 months). It was, however, predicted that the older children would take less time to learn the concept.

Finally it was predicted that a mother, with minimal training, would be able to teach her child to fully operate the microcomputer. The mother's success or failure in this task was based upon her natural ability to sense the appropriate level for intervention and use feedback from her child to guide interventions.

CHAPTER III

METHODOLOGY

Subjects

The subjects involved in this study were 46 preschool children enrolled in a university one-hour enrichment program. Children attended this program twice a week for one hour. While the children explored a Piagetian-based play-school environment, mothers listened to a one-hour lecture on various childrearing topics. There were two groups of children, 2-year-olds and 3-year-olds, which met on alternating days at 9:00 am and 11:00 am.

The mean age for the 2-year-old group was 2.01 years while the 3-year-old group's was 2.83. Of the original 46 children, five did not participate. One child's mother was confined to bed via doctors orders, vacation plans interfered for another, and three others simply did not care to be involved. Children were randomly assigned to either microworld or ABC treatment groups. There were 10 2's and 11 3's in the microworld group and 11 2's and 9 3's in the ABC group. In terms of gender, there were 11 males and 10 females in the microworld group. The ABC group had 12 males and 8 females (see Table 1.).

Table 1

Crosstabulation for Subjects by Age (2) and Sex (2)

		Age: Two's	Age: Three's	Row Total
Sex	Male	9	14	23 56.1
	Female	12	6	18 43.9
	Column Total	21 51.2	20 48.8	41 100.0

The families for both groups of children were intact. Most of the parents were highly educated in that nearly all of them had a bachelor's degree or equivalent. A full third of the mothers had master's degrees, whereas half the fathers had either a master's or doctoral degree.

Design

The design utilized in this study was mixed. As such it includes elements of a Posttest-Only Control Group Design (Campbell & Stanley, 1963) as well as repeated measures. In terms of the posttest-only design, Campbell and Stanley point out that a pretest is not actually essential for true experimental designs since randomization to treatment groups will control for group differences. In fact, the absence of a pretest makes this design somewhat more natural in that generalization to unpretested populations are possible. Since it is the untested population that is usually the object of generalizations, it is logical then to use a design that has this feature built in. The repeated measures are built into the posttest-only design as the mother/child dyads are observed for four consecutive days.

Two additional aspects distinguished this design from Campbell and Stanley's (1963) classic textbook example. First of all, subjects involved in this study represent a convenience sample. They were not randomly selected although randomly assigned to groups. According to Campbell and Stanley (1963); random assignment to treatment groups ensures equivalence. Secondly, a better label for the control or ABC group would have been "placebo-control" group. This group received no true treatment but rather a placebo similar to subjects' being given a sugar tablet in drug studies. The placebo-control or ABC group received a computer experience albeit it was totally different from the microworld group in form as well as concept.

Variables of Interest

Independent Variables. Three variables were identified and were included in the study. The first of these was simply whether the children received the treatment or not. The second independent variable was age. As mentioned before, there were currently two groups of children in the study: 2-year-olds and 3-year-olds. Since these groups were nearly a year apart investigation of performance differences was logical. The final independent variable was a measure of the mother's teaching style. There are five levels of intervention , as shown by Wood and Middleton (1975), that mothers can use in their efforts to help their children achieve some goal. These levels included the following:

1) General verbal instruction. 2) Specific verbal instruction. 3) Mother indicates materials. 4) Mother encourages correct behavior. 5) Mother demonstrates.

Dependent Variables. There were essentially two dependent variables of interest. The first could be described as the total correct responses each child makes on the posttest. The second was the total number of objects correctly placed by the child each day of the intervention.

Instruments

Wood and Middleton Assisted Problem-Solving Scale. As previously mentioned (Chapter II), mothers play an important role in helping their children to problem-solve or successfully complete a task. The instrument to be used in this study to evaluate the mother's role was patterned after the one used by Wood and others (Wood, Bruner, & Ross, 1974; Wood & Middleton, 1975). Changes or revisions were found necessary and are mentioned where appropriate. Wood and others have identified five levels at which a mother could intervene when teaching or helping her child. The first level was termed "General verbal instruction." Examples of verbal instruction, in which a mother outlines a general goal, are "That was good. Can you do it again?" or "What are you going to do next?" Mothers intervening at the second level, "Specific verbal instruction," have been observed to lay down clear parameters for their children's guidance. Examples would be "Can you punch the 'B' key?" or "No, you need to push the A B C keys. The other keys do not work." The third level of intervention, called "Mother indicates materials," is typified by direct intervention from the mother. This is different from modeling, since the mother never actually performs the behavior but merely shows the child which block to pick up or key to push. Mother behavior in this category is usually accompanied by verbal instruction but not always. She might say something like, "You need to push this key to make the tree appear" while pointing to the correct key. Fourth level intervention, in which "Mother encourages correct behavior," is a logical step from level three. The mother operating at this level not only indicates which keys should be pushed but actually selects the key and places the child's finger in suitable orientation for success. This leaves the child with the simple task of pushing the key. Again, this level can but need not be accompanied by verbal instruction of either a general or specific nature. Finally at level five, a mother in the microworld group might behave as follows: she might select an object key (the tree), press the key and cause it to appear, and push various direction keys (up, down, right, left) to guide the object to its correct resting place (inside or outside the house) while the child watches. This is obviously modeling and so this level is called "Mother demonstrates."

It became necessary during the coding procedure to collapse these categories. Levels one and two were combined into "Verbal instruction." Levels three and four became "Mother indicates materials." The fifth level of intervention remained unchanged. Further description of the rationale for these changes was included at a later point.

Five scores are suggested by Wood and Middleton (1975) for use in the analysis. The first, Mother-1, was merely the frequency of interventions in each level. Mother-2 was the frequency with which each of the intervention levels led to successful task or goal completion on the child's part. Mother-3 was a measure of the time mothers spent in the region of sensitivity to instruction. The region of sensitivity has been defined as the borderline between what children are currently capable of doing and what they cannot do. Therefore this score measured the time mother spent in intervention levels below those in which the child was significantly successful (as measured by Binomial tests). Time is measured for levels below significant success because difficulty increases as level number decreases. Level one (verbal instructions) requires children to do more on their own than level three (mother demonstrating). Mother-4 was a measure of the mother's sensitivity to feedback from her child's actions. After each intervention by the mother, the child's success or failure was scored. It was intended to note later which level of intervention mother used next and to calculate the following pattern: 1) child succeeds followed by a lower level of intervention; 2) child fails followed by a higher level of intervention. The total number of these cases would have been divided by the total number of cases to yield mother's sensitivity to feedback. However, during coder-training it became evident that the 5-second record interval, in which no observation took place, made it impossible to tie mother/child behaviors from one 5-second interval to the next. This score was therefore dropped from the analysis.

The last score derived from this instrument was the child success measure. Child success was a measure of the total number of objects correctly placed inside or outside for each day of intervention. A more global version of this score was also obtained. Each time the mother intervened it was recorded whether the intervention led to success or not on the child's part. Then the total number of correct or successful responses was divided by the total number of responses to yield the percentage of successful responses.

In addition to the scores outlined above, the following scores were also calculated to help in the analysis. The number of child successes was further broken down into how many were mother-directed and how many were child-directed. The number of objects correctly placed each day was totaled.

Posttest. The posttest was designed specifically to test the concepts taught in the microworld group. The posttest consisted of a dollhouse divided into five rooms. It had a roof and three sides and was missing the front. Outside the house was a yard made of a green quilted material. In other words, the posttest instrument looked as much as possible like the microworld software background. Children were given objects that resembled those they had manipulated on the computer screen. The child was presented the objects, one at a time, and was asked the following question: "Where does this go? Inside the house or outside the house?" The score on the posttest consisted of the number of times the child correctly placed a given object inside or outside the house and left it there (see Appendix A for posttest materials).

Experimental Situation

A single room that divides in half was used for the observation and videotaping of each group. A sliding partition divided the room in half from top to bottom. Each half of the room could be entered through doors adjacent to a hallway on the south side. The north side of each room contained a two-way mirror behind which was the observation room. Inside the observation room there were four videotape cameras and monitors. Since only two were required for the experiment, two were available as backup equipment.

Procedures

Pilot Study. A pilot study was performed in order to preassess a similar population's knowledge of the concept inside/outside and its familiarity with the objects that were utilized in the microworld group. The pilot study was performed on an equivalent group of 23 preschool children with similar ages and backgrounds. A more general purpose of the pilot study was to ascertain whether children very similar to the target population already knew how to classify objects as belonging inside or outside a house. Children in the pilot study were shown pictures of 30 different objects and asked if they knew what each one was (see Appendix B for list). Then they were asked if the object belonged inside or outside a house. This was done in an effort to find 10 objects, 5 inside and 5 outside ones, that children were familiar with but could not correctly place as belonging inside or outside. These 10 objects were then incorporated into the microworld. It was concluded that children between 18 and 24 months did not know how to classify the objects. They tended to place all of them inside or outside. Between 24 and 36 months children generally knew the correct classification for 1 to 3 objects. Between 36 and 42 months children did very well. These pilot study results were much as predicted by the work of Sugarman (1979).

<u>Habituation of Mothers to Hardware and Software</u>. It was assumed that the mothers involved in this study would share much of the computer=phobia experienced by many in today's technological world. In order to help mothers overcome their phobia (should any exist) and to let them witness for themselves how simple it is to help their children operate the software, mothers were exposed to computer technology on two occasions. First, mothers met in groups of 10 wherein computers and their applications to young children were discussed. Mothers were verbally introduced to the study, and were told that the software in both groups would require single key manipulations to operate. (It was not mentioned to mothers that the microworld software required a series of single-key manipulations for fear of giving away an important difference.) After these informal discussion groups, most mothers indicated their eagerness for their children to experiment with the computers.

The second phase of habituation involved visits to both the 2-year-old and 3-year-old groups with a microcomputer and similar software. Specifically, an Apple IIe with a color monitor and dual-disk drives was used. The software, named "Stickybear Numbers", was chosen for its similarity to that which would be used by the control group and for its ease of use (single key manipulations). Any number key pressed will cause the monitor to display a series of objects, one at a time, that correspond to that number. For example, if the ´3´ key were pressed three cars might drive out to the center of the screen. Pressing the spacebar allows you to add or subtract additional objects depending on the ordinal direction currently under way. After these hands-on experiences, most of the mothers indicated how relaxed they felt with the computer.

Permission Letter. About two weeks prior to data collection mothers were sent a permission letter (see Appendix C), which explained the nature of the experiment and solicited their participation.

Randomization. As mentioned before, the subjects in this study constitute a population since they were not randomly selected. However, the children and their mothers were randomly assigned to treatment groups. Within treatment groups the children were randomly assigned to one of the four consecutive weeks alloted for data collection. Within each day, and as nearly as possible, children were randomly assigned to a particular appointment time, by means of a table of random numbers. The purpose of this randomization technique was to control for rival hypotheses (Campbell & Stanley, 1963). This series of randomizations should have equated the groups with regard to unknown secondary variables.

Data Collection. Data were collected for four consecutive weeks. Within each week data were collected on four consecutive days: Tuesday through Friday. Twelve children per day, six from the microworld group and six from the ABC group, were observed. Children were scheduled for 15-minute sessions and were required to come at the same time every day during a 1-week period. Children and mothers were scheduled to arrive at half-hour intervals starting at 9:00 am. This allowed 15 minutes between each child to restart the software, check equipment, and otherwise get ready.

Treatment. The microworld group interacted with specially designed software patterned after the microworld concept previously discussed. This microworld software was designed to specifically teach the concept of inside-a-house and outside-a-house. The intervention, made up of four 15-minute sessions, lasted for one hour. Research has shown that young children can learn dichotomous concepts in less or equal time. Cooper and others (R. G. Cooper, personal communication, March 18, 1984; Starky & Cooper, 1980) have shown, using the habituation-dishabituation paradigm, that 10- to 12-month-old children can learn to discriminate numerosity of objects in a 15-minute session. In such studies it was hypothesized that when a stimulus no longer interests children, they look away because they have become habituated. Likewise when children exhibit intent interest in a new stimuli, they are said to be dishabituated. Subjects learned to discriminate between three and four object arrays in 15 minutes. Starkey, Spelke, and Gelman (1982) have further shown that 16-month-old children can learn to discriminate between greater-than and less-than in 20 minutes. Furthermore, Yarrow

(1982) has shown that 13-month-olds are very persistent in tasks spending as much as 60 percent of their time engaged in one activity.

Here is how the software worked. Children, in their mothers' laps, worked at an Apple IIe microcomputer with dual-disk drives, an Amdek color monitor, and Sprite-Logo parallel interface card. It was "Sprites" that made the creation of microworlds possible. Sprites are 16x16 graphic grids that can be defined in any way the programmer desires. Thus they can become birds, trees, cars, trucks, etc.

The microworld was programmed to function as follows. All keys on the keyboard were covered with blank stickers except for keys necessary to make the software function. Ten of these keys were covered with pictures of objects they controled -- five objects that belong inside a house and five that belong outside a house. Four additional keys functioned as manipulators for the object keys. These were the four arrow keys and pressing them caused the object on the screen to move a preset distance in the direction indicated on the key. With this software a child might press the object key with a tree on it and then use the arrow keys to move the tree to a specific place in the yard outside the house. This could be done with all ten object keys. This software included "stop" and "go" buttons. The go button caused the software to function. When satisfied with the position of a particular object, a child could push the stop key, press another picture key, and then press the go button to begin object manipulation again. When complete the monitor screen should depict five objects inside the house and five objects outside the house. It did not matter where the objects were as long as they were appropriately inside or outside the house.

It is important to note that the concept inside/outside does not violate the previous literature review. Gelman and Baillargeon (1983) have pointed out that basic objects like the ones in this study (car, table, swing, lamp) can be sorted by any or all of a number of criteria (shape, function, etc.). They further noted that young children will have no trouble selecting a basis of classification; however, in this case they were given one. On the other hand, Osler and Kofsky (1965) warned that the greater the number of dimensions that must be ignored, the less obvious or salient the basis for classification will be. For this reason, great pains were taken to ensure the microworld corresponded to much of what is known about how young children learn. Jackson, Robinson, and Dale (1976) functioned as the basis for most of this. In a thorough review of literature they outlined a number of factors essential for successful teaching of young children. For example, to help them discriminate, the microworld was large and brightly colored, and the moving objects were silhouetted against the large, colorful background. Furthermore, the house/yard scene with objects that belong in or out of the house was chosen for its relationship to the child′s previous experiences. If, as Piaget (1972) has stated, young children pay closer attention to events and stimuli that are only slightly different from what is familiar to them, the microworld will not overwhelm them. Finally, to help them remember (Jackson et al., 1976) another experience was also influential in the design of the microworld. This was a familiar scene that contained an internal organization (all 10 of the objects could be used to create a scene much like their own home) to help them organize the new information in a meaningful way. In this experience, children did not sit and passively watch, but were actively involved in touching and manipulating hardware and software. Moreover, children were given more than one exposure to the information.

Children in the ABC group worked with drill and practice software designed to drill the alphabet. Specifically, "Stickybear" ABC′s were used. All keys but the alphabet keys were covered with blank stickers and were non=functional. Any letter key caused the computer to respond with a highly colorful, graphic symbolization corresponding to the key pressed. For example, if the "K" key were pressed the monitor displayed Stickybear and his mate kissing.

<u>Experimenter</u>. The experimenter′s responsibilities included greeting mother and child, instructing the mother how to operate the microcomputer, giving the mother a goal to work towards, and operating the videotape machines (see Appendix D for instructions to experimenter).

The experimenter greeted mother and child at the door to the observation room and showed them to the computer. The mother was shown how to operate the software while her child sat quietly in her lap. As mentioned before, this involved no more computer expertise than a series of single-key manipulations. Since the object was for the children to learn how to operate the machine, they were encouraged to observe their mothers using the software. Furthermore, since the computer was already on and running, mothers were not bothered with computer functions.

After a minute or two of instructions and reference to the help chart near the computer, the mother was instructed to place her child in her lap and the intervention began. Each session lasted for approximately 15 minutes. Mothers were given minimal training in order to make the situation as analogous to the home as possible. In the home situation, when software has been purchased, no one is present to instruct the mother in its proper application. The mother was told she could stop whenever her child was finished.

The experimenter issued the following instructions to the mothers of the microworld group.

> This is an Apple IIe microcomputer with software specifically designed to teach the concept inside-a-house/outside-a-house. Pushing the keys with pictures on them and then the "go" button will cause a corresponding graphic object to appear in the neutral area on the screen. Pushing the arrow keys will cause the object to move forwards, backwards, right and left a preset distance. Pushing the "stop" button will cause the object to remain where you have placed it and allow you to call up another. Pushing any other key will have no response.
>
> Five objects belong inside the house (TV, Potty, Lamp, Table, Bed) and five belong outside the house (Swing, Stop Sign, Slide, Car, Fence). Your job is to help your child learn how to operate this software. Would you like a practice trial or two?

In the same manner, the experimenter issued the following instructions to the mothers of the ABC group:

> This is an Apple IIe microcomputer with software specifically designed to drill the alphabet. Pushing any letter key will cause a corresponding graphic symbolization to appear on the screen. Pushing other keys will have no response. There are two such pictures for each letter key. Your task is to help your child learn how to operate the software. Would you like to try it for a few seconds?

The instructions to mothers of both groups were modified upon occasion as needed. For example, in the microworld group it was soon discovered that if the child banged the keys hard enough, the software would crash. In other words, the screen went blank and the computer ceased responding. It became necessary to warn mothers in this group of such possibilities.

Posttest Administration. Each Friday, at the end of each 15-minute intervention, the experimenter reminded each mother that in order to evaluate the computer experience, her child needed to participate in a game that would last approximately 15 minutes. At this point the experimenter ushered mother and child to another room where a second experimenter waited to present the posttest. To control for testing bias, this experimenter was blind to the group the children had been in. Children were shown the doll house described earlier. They were handed an object one at a time and asked the following question: "Where does this go? Inside the house or outside the house?" The experimenter recorded the number of correct and incorrect responses. A score on the posttest consisted of the number of times each child correctly placed a given object inside or outside the house and left it there (see Appendix A for posttest materials).

The mother was given a questionnaire to fill out at this point in order to keep her busy so that she would not coach her child through the posttest. However, it was found that it was often necessary to have the mother translate the younger children's answers if they were not accompanied by action.

Data Coding. The sessions with mother and child interacting together at the microcomputer were videotaped and coded for the behaviors described above (see Appendix E for coding instructions). For each mother's intervention observed, a corresponding mark was made on the score sheet. The observers used the numbers 0 through 3 to indicate at which level of intervention the mother was operating (zero meaning no intervention); coding was done in 5-second intervals to facilitate management and reliability checks. To help coders identify mother behaviors Wood and Middleton (1975) defined an intervention as whenever the mother directed the child, either by word or action, toward some task activity or goal. An intervention was terminated in two ways (Wood, Bruner, & Ross, 1974; Wood & Middleton, 1975): first, when the child attempted a new or different activity or in any other way changed what he was doing; second, "when the child is not moved to action by mother's suggestion and she moves on to suggest a new goal or operation (p. 184)." However, this second type of termination was conditioned upon goal change. As long as the mother continued to suggest or request the same behavior, the intervention was deemed to continue until such time as the child acted. If a new goal was suggested by the mother, then the intervention was said to have terminated. In situations where more than one level of intervention was present at the same time -- e.g., the mother showing as well as instructing verbally, only the highest level of intervention was scored.

In addition to the levels of intervention just described, it was also recorded whether the mother's intervention led to successful task completion or goal achievement for the child. Success was simply whether or not the child had accomplished whatever task or goal the mother had set. In this particular situation it would be moving a video-object inside or outside the house or pressing the correct letter key. Coders used the numbers 0 and 1 to record child behaviors (see Appendix E for coding materials). It was also recorded whether the success was child-directed or mother-directed, and which objects were classified correctly.

The instrument used in this study has proven to be reliable on several occasions (Wood & Middleton, 1975) with reliabilities of .90 to .94 between coders. The method used to establish and maintain reliability for this study was as follows: Two observers were trained to code the videotapes using a revision of the Wood and Middleton (1975) instrument described earlier and a training videotape made solely for that purpose (see Appendix E for coding materials). Coders trained for one week to reach a criterion reliability of .90. Final reliabilities for the microworld group reached .82 for mother behaviors and .86 for child behaviors. Reliability for the ABC group reached .82 for mothers and .88 for children. The method for calculating reliability was as follows: the number of agreements divided by the number of agreements plus the number of disagreements. After the above reliabilities had been reached checks were made 20 percent of the time during data coding. This amounted to a reliability check after every forth dyad was coded. Since there were 41 dyads and 4 treatment sessions per dyad that made a total of 164 treatment sessions to be coded. Therefore, every fifth session was a reliability check. To further ensure reliability all treatment sessions for the microworld group were coded first followed by the ABC group sessions. Observers were blind to how treatment groups differed, purpose of the study, and reliabilty checks.

Quite an elaborate setup was required for the coding of data in order to maintain the controls necessary to ensure reliability. Two coders and a third head-coder worked simultaneously in a video equipment room reserved for that purpose. Data coders sat in front of large-screen videotape monitors separated by a partition. Behind the partition and out of sight of the coders sat the head-coder, who was responsible for running the two videotape machines which allowed coders to code two sessions at at time. After every fourth treatment session was coded, the head-coder would flip a silent switch which resulted in the coders watching the same session. This made it possible for coders to work on different treatment sessions and, without their knowledge, view a single session simultaneously for reliability. The coders each had headphones which allowed them to listen to the tape soundtrack with one ear and the observation tape with the other ear. The observation tape contained the words "observe" and "record" spoken in 5-second intervals for 15 minutes. The headphones also kept coders from hearing each other's tape-dialog and knowing when a reliability check was being made.

During the training week it was discovered that reliability would not reach .90 or higher. Upon evaluation this was concluded to result from the complexity of the treatment sessions. Coders were required to watch two people, listen to dialog, watch the keyboard, watch the computer screen, look for object manipulations on the computer screen, and look at hands manipulating the keyboard, in addition to the usual distractions that accompany coding from videotape such as audio distortion and glare from the screen. In light of these contingencies, reliability consistently above .80 constitutes a heroic effort on the part of each coder.

In order to reach a reliability of .80 or better, it became necessary to simplify the coding scheme. For this reason the five levels of mother intervention were reduced to three: verbal instruction, mother indicates materials, and mother demonstrates. It was decided to combine the mother intervention levels because the small one-step differences between them were the major contributions to the low reliabilities.

<u>Statistical</u> <u>Analyses</u>. The following statistical analyses were performed to test the hypotheses previously stated:

First, Wood and Middleton (1975) have suggested the calculation of a score which is simply the number of times a mother uses each particular intervention level. As a purely descriptive measure, if the score is smaller at the end of intervention than at the beginning, then the mother must have reliquished more control over the hardware and software to her child. The sign test was utilized to determine significant changes from day to day.

Pearson correlations were performed to ascertain if there was any relationship between age and performance on the posttest, if mothers were aware of their children's region of sensitivity to instruction, if a relationship existed between mother's awareness and children's success during intervention, and if any single intervention level was more effective than the others. A Spearman correlation was performed to ascertain if mother's choice of intervention strategy was due to feedback from her child or something else. It was also predicted that older children would respond more to lower levels of intervention whereas younger children would require higher levels.

A Kendall's Test of Concordance was performed to ascertain whether the mothers in each group agreed on which levels of intervention to use. If agreement existed, then mothers were governed by feedback from their children. Kendall's Coefficient of Concordance was also performed on the rank order of children's success with each intervention level to test whether children responded the same to intervention levels.

To test the hypotheses that no significant difference will exist between treatment groups and age groups on the posttest, a two-way ANOVA was performed. Each of these hypotheses represents a main effect to be tested. Simple main effects were employed to interpret the interaction.

A (day X age X subjects) repeated-measures ANOVA was performed on the number of objects correctly placed each day to test the hypothesis concerning how long it took to learn the concept. Again, each main effect in the model represented a hypothesis. It was further predicted that older children would learn the concept in less time than the younger.

Descriptive statistics were performed on the results of the questionnaire administered during the posttest session. These demographics were used primarily for further description of the population.

CHAPTER IV

RESULTS

Description of Subjects

This section will describe several features of the population not reported in Chapter III.

Microworld Group. There were 21 preschoolers in this group. Of that total 16 (76%) mothers said they did not own a microcomputer, 4 (19%) said they did, and 1 (5%) failed to answer the question. Of the four who had bought micros, no mothers said they had done so for their children's entertainment, but rather for educational purposes. It is further interesting to note that 18 of the 21 mothers (86%) indicated that they thought microcomputers were appropriate at the preschool level. One mother did not feel that way and 2 failed to answer (14%). The same 18 mothers also indicated they felt the microcomputer would be beneficial in a preschool curriculum. Three mothers did not answer. Of the 16 mothers who said they did not own a microcomputer, 11 (69%) indicated they planned to purchase one in the near future.

ABC Group. There were 20 mother/child dyads in this group. Four (20%) of these families had also purchased a microcomputer. Whereas in the microworld group none of the computers had been purchased for entertainment, 50% of those purchased in the ABC group were intended for their child's entertainment. As in the other group a great majority

(90%) of the mothers said they felt the microcomputer was appropriate at the preschool level and of benefit as a part of preschool curriculum. Of the 16 mothers who currently did not own a computer, 10 (63%) indicated plans to purchase one soon.

Analysis of Data

All data was analyzed using the SPSSX statistical package for the social sciences (Nie, 1983).

Hypothesis 1a.

It was hypothesized that by the end of a one-hour intervention, children would be operating the software by themselves as indicated by mother's use of lower levels of intervention.

Microworld Group. Evidence exists to confirm this hypothesis for the microworld group. Sign tests were performed on the total frequencies of each intervention level with the following results: Total amounts of "mother indicates materials" and "mother demonstrates" decreased significantly from Day 1 to Day 4, respectively. The mean for "mother indicates materials" at Day 1 was 24.71 and Day 4 was 12.62. The sign test indicated this difference to be significant at $p<.05$. The mean for "mother demonstrates" for Day 1 was 38.52 and Day 4 was 23.71. The sign test indicated this difference to be significant at $p<.001$. Furthermore, total amounts of "mother verbal instruction" and "no intervention" increased significantly from Day 1 to Day 4. The mean for "mother verbal instruction" for Day 1 was 16.81 and for Day 4 was 36.57. The mean for "no mother intervention" for Day 1 was 3.38 and Day 2 was

11.43. Sign tests indicated these to be significant with $p<.0001$ and $p<.001$, respectively.

ABC Group. Support for hypothesis one can not be obtained for this group. There were no significant differences in the total amounts of any mother intervention strategy between Day 1 and Day 4. It seems mothers did about the same from day to day with little change.

Hypothesis 1b.

It was hypothesized that level three, Mother Demonstrates, would allow the least child success (hardest) followed by level two, level one, and no intervention. Several types of success were possible for a child. For this particular hypothesis, success was scored anytime the child correctly followed mother intervention.

Microworld Group. Support for this hypothesis was not confirmed for this group. Kendall's Coefficient of Concordance revealed significant agreement among children, $W=.5817$, $p<.0001$, as to which mother interventions yielded the most success. For this group children's rank ordering of intervention level by total frequency of success yielded the following: Children were most successful when mother used "verbal instruction (mean rank=3.45)" or "indicated materials" (3.17). They were least successful when she "demonstrated" (1.98) or did not intervene at all (1.40).

ABC Group. Although significant agreement (Kendall's $W=.5484$, $p<.0001$) existed among children in this group, it failed to support the hypothesis. Children in the ABC group found it easiest to succeed when mother used "verbal instruction" (mean rank=3.28). This was followed by "no intervention" (3.15), "indicates materials" (2.38) and "demonstrates" (1.20).

Hypothesis 2

It was predicted that mothers would adjust their intervention strategies as a result of feedback from their children and not because of some intrinsic teaching style. Specifically, it was predicted that child success or failure would determine which level or strategy mother used next. Success was again broadly defined as any time the child correctly followed mother intervention.

Microworld Group. Partial support for this hypothesis was previously outlined. The fact that mothers in this group made a significant change from high-control-oriented interventions to low-control-oriented intervention indicated they were following the cues implicit in the children's success experiences (see Hypothesis 1a). Spearman's Rank Correlations between age of child and rank ordering of intervention use further support this hypothesis. Two important relationships emerged. First, the older the child, the more likely mother was to use verbal instruction ($r=.5131$, $p<.05$). Second, the younger the child, the more likely mother was to intervene ($r=-.5089$, $p<.05$). Age, therefore, emerged as an important factor in mothers' decisions to intervene or not. Finally, a highly significant positive

Pearson's correlation (r=.7021, p<.001) between "total child-directed success" and "no mother intervention" revealed that mothers were sensitive enough to allow their children to do what they could when they could.

ABC Group. Little support for hypothesis two can be found in this group. There were no significant correlations between age and rank ordering of intervention levels. Nor were there any significant changes in intervention levels between Day 1 and Day 2 (see Hypothesis 1a for figures). However, a highly significant Pearson's correlation (r=.9205, p<.0001) indicated that the more mothers did not intervene, the more children experienced success on their own.

Hypothesis 3.

It was predicted that a mother would show a natural awareness of her child's "region of sensitivity to instruction." This was previously defined as the borderline between what the child is currently capable and incapable of doing. It was predicted that children of mothers who spent more time intervening or teaching in this region would be more successful. Success was measured globally as the total percentage of successful experiences (placing objects and pressing correct keys).

Microworld Group. No support for this hypothesis was found in the microworld group. A Pearson's correlation between the time mothers spent in the "region of sensitivity to instruction" and "percentage of child success" was not significant (r=.3023, p<.20). Furthermore, a Kendall's coefficient of concordance test revealed that mothers significantly agreed on what interventions to use, $W=.4558$, $p<.001$. Mothers in this group used the intervention levels in the following manner: "mother demonstrates" (mean rank=3.24), "mother verbal instruction" (2.81), "mother indicates materials" (2.71), and "no intervention" (1.24). This indicates that mothers were governed by other factors than their children's region of sensitivity.

ABC Group. Similar results were obtained for this group as well. A Pearson correlation of .2918 ($p<.20$) revealed no significant relationship between mother's awareness of her child's sensitivity to instruction and the percentage of success experienced by the children. In addition, a Kendall's test ($W=.6250$, $p<.0001$) revealed that mothers in this group agreed upon a somewhat different pattern of intervention use. "No intervention" (mean rank=3.85) was first, followed by "mother verbal instruction" (2.70), "mother demonstrates" (1.90), and "mother indicates materials" (1.55).

Hypotheses 4a & 4b

It was predicted that as a result of the one-hour microcomputer intervention, microworld children would correctly categorize a series of objects as belonging inside-a-house or outside-a-house. on the posttest than children in the control (ABC) group. It was further predicted that the 2-year-olds would perform as well on the posttest as the 3-year-olds.

Microworld vs. ABC Group. A 2x2 ANOVA (Keppel, 1982) revealed moderate support for this hypothesis. No significant main effects for group ($F(1,37)=.448$, $p<.51$) or age ($F(1,37)=.074$, $p<.80$) were produced. However, the age by group interaction was nearly significant, $F(1,37)=3.98$, $p=.053$ (see Table 2.).

Table 2

Analysis of Variance Summary for Total Objects Classified by Group (2) by Age (2)

Source	SS	df	F	Prob.
Group	5.015	1	0.3759	0.544
Age	0.622	1	0.0466	0.830
Group*Age	53.121	1	3.9820*	0.053
Error	493.474	37		

Note. The group*age interaction approaches significance.

Examination of means by way of simple main effects (Keppel, 1982, pp. 214-215) revealed that no two means were significantly different at the alpha=.05 level. Nevertheless, the simple main effect for three-year-olds by groups approached significance ($p<.10$) (see Table 3.). Post hoc power calculations (Keppel, 1982, p.78) for the simple main effects revealed power to be .53, phi(1,18)=1.86.

Table 3

Simple Main Effects of Total Objects Placed

for Age=3 by Group (2)

Source	df	SS	F	Prob.
Between Groups	1	46.0626	3.0069	.1000
Within Groups	18	275.7374		

In spite of low power, the strength of the effect is enough to cause the interaction to approach significance. One can see that two-year-olds performed about the same regardless of group. On other hand three-year-olds in microworld group did somewhat better than those in the ABC group (see Table 4.).

Table 4

Means and Standard Deviations of Total

Objects Classified by Group (2) by Age (2)

Variable	Mean	SD	n
Microworld	7.3333	3.4400	21
Two's	6.3000	3.7431	10
Three's	8.2727	3.0030	11
ABC Group	6.6500	4.0429	20
Two's	7.8182	3.0271	11
Three's	5.2222	4.8161	9

Hypothesis 5.

It was predicted that it would take a minimum of three days for the 3-year-olds and four days for the 2-year-olds to learn the concept of inside/outside.

Microworld Group. A mixed-design repeated measures ANOVA [A x (B x S)] was performed to investigate this hypothesis (Keppel, 1982). Analysis revealed no significant between-groups effect for day [$F(3,57)=.21$, $p<.90$] nor was there a significant Age by Day interaction [$F(3,57)=1.57$, $p<.20$] (see Table 5.).

Table 5

Repeated Measures Anova Between-groups Effects of Total Objects Placed for Day (4) and Age*Day

Source	SS	df	F
Day	2.06180	3	.20700
Age*Day	15.68084	3	1.57432
Error	189.24773	57	

However, there was a highly significant within-groups main effect for Age ($F(1,19)=25.61$, $p<.001$) (see Table 6.). Since there was no significant age X day interaction, it can be concluded that the 3-year-olds in the microworld group correctly placed significantly more objects on a daily basis than did the 2-year-olds. The means of the 3-year-olds were 6.4, 7.4, 7.3, and 7.2, respectively, compared to 3.0, 2.4, 1.6, and 1.9 for the 2-year-olds (see Table 7.).

Table 6

<u>Repeated Measures Anova Within-Group Effects of Total Objects Placed for Age (2)</u>

Source	SS	df	F
Age	492.39058	1	25.61359 *
Error	365.25227	19	

*p<.0005

Table 7

<u>Means and Standard Deviations for Total Objects Placed by Day (4) by Age (2)</u>

	Age	Mean	SD	n
Day # 1				
	2	3.00000	3.92428	11
	3	6.40000	2.71621	10
Day # 2				
	2	2.36364	3.04213	11
	3	7.40000	2.87518	10
Day # 3				
	2	1.63636	1.85864	11
	3	7.30000	2.58414	10
Day # 4				
	2	1.90909	2.16585	11
	3	7.20000	1.68655	10

Additional Analyses

Binomial tests were performed to ascertain under which levels of mother intervention were children significantly successful ($p<.05$). Success here was defined as the total number of times mother interventions resulted in child success (for both groups). One tailed tests were performed on the total number of successes by intervention level to determine when the number of successes was greater than 50% of the total interventions. The resulting significant intervention levels were utilized in the calculation of the time mothers spent in the children's region of sensitivity to instruction. Some interesting results are apparent when the results of the binomial tests alone are looked at.

Microworld Group. Only 8 (38%) of the 21 dyads in this group experienced significant success. Of those 8, only 1 (13%) was a 2-year-old, the rest were 3-year-olds (.875 percent).

ABC Group. In this group the results were a little different. Twelve (60%) of the 20 dyads experienced significant success. Five or 42% were 2-year-olds 7 or 58% were 3-year-olds. The type of software seems to make little difference here.

Pearson correlations were also performed to determine if any relationship existed between age of child (in months), total time spent at the computer (in minutes), and score on the posttest.

Microworld Group. A highly significant correlation (r=.5996, p<.01) existed between age and posttest score. A moderately significant relationship between age (r=.4903, p<.05) and total time spent also existed. For this group then, the older the child, the higher the posttest score and the longer the child stayed at the computer.

ABC Group. A highly significant relationship (r=.6748, p<.001) between age and posttest score was found. No relationship exists (r=.2557, p<.30) between age and total time spent. For this group the older the child, the higher the posttest score. However, there is no relationship between age and time spent at the computer.

CHAPTER V

DISCUSSION

Control Over Software Operation.

As predicted, mothers in the microworld group relinquished control of the software to their children as competency developed. This was not the case for the ABC group. Mothers in this group made no significant changes over the 4-day intervention session. Perhaps this can be explained by the nature of the software utilized in the ABC group. Whereas the microworld software required a great deal of mother/child interaction in order for the children to learn how to use it, the ABC software was simpler to operate. All one needed to do was punch any letter key and the computer would respond with highly stimulating graphic displays. It is obvious that mothers were required to teach their children little except to hit buttons. In the microworld group, mothers had to teach their children first to select an object to "play" with and then to push the "go" button so the object could be manipulated. Next, mothers had to teach their children that the arrow keys were necessary to move the object around the screen. Finally, mothers had to teach that when children finished with an object, they had to press the "stop" key in order to fix the object at its location. Certainly this software, however simple, was more complex than the push-any-key ABC´s. So from the very beginning, mothers in the ABC group had very little to do. Is it any wonder they chose not to intervene a great majority of the time? Personal observations support this as well. During the interventions children in the microworld group were often observed to slap the keyboard out of frustration. This rarely occurred in the ABC group for there was little with which to become frustrated.

Mother Intervention and Child Success.

Some interesting differences existed between the groups that can also be attributed to basic software differences. For the microworld group it was hardest for the children to experience success when mothers did nothing at all or when they demonstrated how to do it. This makes sense when one considers the software. The four steps outlined above for microworld operation were complex enough that without some help from the mother, even just a verbal prompt or point of a finger, it was difficult for a child to be successful at first. On the other hand, when the mother demonstrated, she tended to do the whole thing leaving nothing wherein the child could succeed. It has been shown (Hypothesis 1a) that mothers in the microworld group started out using the higher control oriented levels of intervention (demonstrating and indicating materials) and as time progressed they moved to using the lower-level interventions (verbal or no intervention at all). The significance of this is that mothers were responding to the needs of their children and changing their intervention strategy as children gained competency with the software.

Mothers in the ABC group did not display this tendency to yield more and more control over the software to the children. Again, perhaps the easy nature of the ABC software made this strategy unnecessary. Surely mothers could see that children in the ABC group were successful with that software from the first moment they sat down in front of the computer. This might also explain why children in the ABC group experienced the most success when mothers used verbal instruction or nothing at all. Since so little teaching was required of mothers, they found that verbal instruction was sufficient when they did need to intervene.

Following Feedback from Children.

It was predicted, based on the work of Wood and others (Wood & Middleton, 1975; Wood, Bruner, & Ross, 1974), that mothers would alter their intervention strategies based upon feedback from the children's successes and failures. As previously mentioned, coding difficulties interfered with the calculation of the intended scores that would have more accurately reflected the mothers' behavior in this area. It was decided that coding would be done in 5-second intervals. This method was chosen to facilitate synchronization of coders so that frequent reliability checks could be made. During the coder training week it was discovered that the 5-second record period was long enough for dyads to change what they were doing. This eliminated the contiguity between the 5-second blocks. The immediate result of this, as Wood & Middleton (1975) suggested, was the inability to calculate the pattern of the mothers' behavior. Did they respond with a lower level of intervention to child success and a higher level to child failure? For the moment, it is impossible to say except to point out that Sign tests revealed a significant overall change in the microworld mothers' interventions from beginning to end of treatment. These mothers decreased their use of the high control interventions and increased use of low-control interventions. As already pointed out, ABC mothers made no such changes from day to day probably due to the simple nature of the software with which they were dealing. In terms of the future it is recommended that coding be done by mothers' intervention rather than 5-second on/off intervals. This would amount to continuous coding and would make it possible to see when mothers shift their pattern of intervention and whether it was in response to the children or not. (The length of coding intervals would be determined by the mothers' interventions.) Wood and Middleton (1975) gave operational definitions describing when interventions begin and terminate. These are all that are needed to code behaviors as suggested. With this method it would be necessary to first train coders to a criterion reliability on recognition of intervention patterns. They would then be ready to train on the other behaviors.

It is still possible to make some definite statements about mothers' ability to follow feedback from their children. Although it was predicted that mothers would cue their interventions from children's successes or failures, there were other cues mothers could rely on as well. For instance, mothers were well aware of their children's age and consequently their abilities. As was shown, a significant relationship existed between the child's age and how the mother responded. The older the child, the more likely the mother was to use verbal instruction as a means of intervention. Personal observation attested to this. Microworld children approaching the age of 2.5 to 3.0 years had little trouble learning to operate the microworld software. In fact, they often appeared bored by the third day of the treatment. Mothers responded differently to younger children. The younger the child, the more likely it became that mother would intervene in some way. Although the current instrument was not sensitive enough to report exactly what intervention was used, personal observation indicated that mothers of the youngest children did a lot of demonstrating.

Further evidence in favor of mothers' ability to follow feedback can be witnessed in the highly significant correlations between 'no intervention' and 'total child directed success.' For both groups it was evident that mothers were willing to let their children do as much as possible on their own. For the ABC group it did not take long for mothers to sit back, so to speak, and let their children control the software. However, in the microworld group it took a bit longer, hence the lower correlation ($\underline{r}$(abc)=.9 vs. $\underline{r}$(micro)=.7). Personal observation attested to the fact that no mother refused to interact. Mothers withdrew when it became evident that the children could operate the software by themselves.

Region of Sensitivity to Instruction.

Although some global evidence existed to indicate that mothers in the microworld group were aware of and did follow feedback cues from their children, there was no evidence to indicate they were aware of the region of sensitivity to instruction. ABC group mothers also showed no awareness of this region. These statements are based on the lack of any significant relationship between mother activity in the region and total percentage of child success. Wood and Middleton (1975) predicted mothers would be the best teachers of their own children because they are aware of the borderline between what their child can and cannot do. Evidence has been cited to show that not only mothers but teachers are aware of and concentrate their teaching around this region of sensitivity to instruction (Wood & Middleton 1974; Wood, Bruner, & Ross, 1974). Are we to believe that these upper-middle-class, highly educated mothers were not aware of this borderline area in their own children? Again, a close look at the types of software to which mothers were exposed can go a long way toward explaining this phenomenon. ABC mothers had little to teach their children about software operation. It sometimes looked as though their only function was to provide a warm cushion for the children from which to reach the keyboard. Note here that mothers in this group, as revealed by Kendall's test, did not intervene the majority of the time. According to rank ordering of their intervention use, ABC mothers chose 'no intervention' the most. One explanation for their behavior might be that since the ABC software provided instantaneous success for the children, mothers had little to do. Personal observation supported this conclusion. Mothers in this group spent a great deal of time teaching the ABC's to their children. They would trace the letters on the screen, make the sound of the letter, and ask their child to name it. Often it appeared as though these mothers were filling their time with meaningful activity.

Microworld mothers, in a manner of speaking, had their hands full. It has already been shown that a four-point plan had to be taught and reinforced if children were to gain competency and take over operation of the software. Secondly, shortly after treatment began it was discovered that children could "crash" the microworld software in a couple of ways, either by banging the keys very hard a number of times, or by pushing two keys simultaneously anytime between pressing "stop" and then "go". When the software crashed the screen went blank and the computer stopped responding. It was then required of the experimenter to come out of hiding, reload the software, and start the intervention all over again. Personal observation attested to how nervous mothers in the microworld group became once the software crashed. The primary concern voiced by all of these mothers -- and it happened to nearly everyone at least once -- was that the children might break the computer. No amount of reassurance was able to dispel this concern. Mothers kept apologizing for any possible destruction to the machine. It should be pointed out that it was virtually impossible to crash the ABC software.

Perhaps it should be noted that the difference here was between commercial software and "homemade" software. It has since been discovered how to correct this problem in the microworld software so that similar problems in the future can be eliminated.

The results of the Binomial tests performed also attest to the difficulty of the microworld software when compared to the ABC software. Only 38% of the dyads in the microworld group experienced a significant amount of success (over 50% of interventions) whereas 60% of the ABC dyads did.

Microworlds and Classification.

It was predicted that the microcomputer, specifically the microworld software, would be an effective way of teaching young children to classify. This prediction was based on evidence that children in this age group begin classifying and advance rapidly in their ability to do so (Sugarman, 1979), and on the assumption that microworlds would create new inroads into cognitive development (Papert, 1980a). As previously indicated results were somewhat mixed. The microworld had no overall group effect on the ability to classify basic level objects according to a simple scheme. Generally children's responses on the posttest could have been predicted from the research literature on classification in young children reviewed in this work (Gelman & Baillargeon, 1983; Sugarman, 1975; Sugarman, 1979). Children younger than 24 months had a tendency to place all of the objects either inside or outside of the house. Children 24 months and older were more likely to place objects from the array in both orientations. The older the child, the higher the posttest score (r(micro)=.5996, $p<.01$; r(abc)=.6748, $p<.001$).

It is important to note that this task was a little more difficult than the typical classification task (Nelson, 1977; Ricciuti, 1965; Sugarman, 1979). For the posttest, children were required to classify a variety of basic-level objects (car, table, lamp) by the scheme inside/outside rather than pick circles and triangles or other identical items from an array. Secondly, children were required to shift from graphic pictures to real objects. Daehler, Lonardo, and Bukatko (1979) have shown that children between 20 and 32 months can make equivalence judgements successfully when dealing with object-object arrays. However, their subjects had equal difficulty making equivalence judgements in either the object-picture, picture-object, or picture-picture conditions. In order to compensate for the crippling effect presented by the picture-object shift, a verbal label was given each object during the posttest. Daehler et al. have shown that the addition of a verbal label significantly improved equivalence judgements. Thirdly, Daehler et al. as well as Denny and Moulton (1975) have shown that complementary relationships (spoon-bowl) do not become a salient basis for grouping until subjects are 3 years or older. Therefore, the complementary relationship between the objects and their belonging inside or outside the house added an additional complexity to the task.

Increased complexity was essential to the goal of this study, which was investigation of the assumption that microworlds provide a rich environment for cognitive development. In order to test this assumption the task had to be more difficult so it could not be argued that the children would have done as well without the microworld. The decision of how much to increase difficulty and when to stop was based on the studies cited above.

As it stood, the microworld children, as a group, did not learn to classify any better than the ABC children, nor were there any overall age differences between the 2-year-olds and the 3-year-olds. However, the microworld 3-year-olds, as evidenced by a nearly significant age-by-group interaction, classified more objects correctly on the posttest than the 3-year-olds in the ABC group. As noted before, the power (1-beta) to detect a significant difference between these means was quite low (.53). Keppel (1982) suggested that when power was low the possibility existed that the null hypothesis was false. He suggested additional post hoc power calculations to determine how many more subjects would be necessary to increase power sufficiently. If a reasonable amount was required, then the study was worth replicating. If an unrealistic amount was required, then the findings were of no practical value (effect too small). Several such power calculations were performed, and it was determined that doubling the sample size, 20 versus 10 per cell, would increase power to .86 (phi(1,18)=2.64). Keppel (1982) has indicated .80 to be an acceptable power level (p. 79). These additional investigations made it possible to conclude with a great deal of confidence that the interaction effect was very strong. This is further supported by a highly significant within-groups main effect for age from the repeated measures ANOVA. Three-year-olds in the microworld group correctly placed more objects inside and outside the house on a daily basis than 2-year-olds in the same group. Since these children were performing a slightly more difficult task than research had shown was possible for their age group, this finding emerged as quite significant.

It appears, therefore, that for the 3-year-olds in the microworld group, children cognitively ready for the experience (Sugarman, 1975; Sugarman, 1979), the microworld provided the materials and experience necessary to produce advanced cognitive behavior. Personal observation attested to child readiness for this experience; most of the 3-year-olds in the microworld group mastered the software by the third day and thereafter became somewhat bored.

Two-year-olds' failure to respond to microworld instruction brought several things to mind. First, it may simply be that the intervention was too short. DiRenzo's (1983) toddlers (18 to 36 months) received extensive preparation and over 3 hours of instruction before being able to direct graphic cars or hit targets. Personal observation showed that children this age were often frustrated with their inability to operate the software. Very often the youngest children had a great deal of difficulty staying at the computer for the whole 15 minutes ($\underline{r}$(micro)=.4903, $\underline{p}$<.05). This was never the case with the ABC software. Children of both ages would have sat there as long as allowed ($\underline{r}$(abc)=.2557, $\underline{p}$<.30). Secondly, the microworld software may have presented more stimuli than the younger children were capable of disregarding. This warning was voiced earlier by Osler and Kofsky (1965), who noted that the greater number of dimensions that must be ignored, the less obvious or salient the basis for classification would be. In spite of the fact that extreme caution was taken in the development of this software, so that the basis for classification would be as salient as possible, it may simply have overwhelmed the 2-year-olds. However, the fact that the 3's were not overwhelmed by the software is very significant. It may mean they are capable of more complicated classification than previously thought.

These findings are relevant to the current literature on classification in the following ways. First, as Inhelder and Piaget (1964) have noted, children in this age group were expected to fail the posttest. Their predicted inability to classify should have resulted from getting "caught up" in the relationships among the objects themselves (spatial arrangements or idiosyncratic resemblances such as all the same color or size) (Gellman & Baillargeon, 1983). The behavior of microworld 3-year-olds in this study clearly contradicted these predictions. These children did not exhibit the "graphic" characteristics attributed to them by Inhelder and Piaget (1964). Rather they behaved more as Smiley and Brown (1979) have indicated and followed a more thematic construction. The 3-year-olds' ability to classify according to the inside/outside scheme also corresponded with Gelman and Baillargeon's (1983) assessment that preschool children preferred part-whole organizations as opposed to class. The thematic, part-whole relationship of the 10 objects to the microworld software was basic to its development.

Furthermore, the classification skills evidenced by the microworld 3-year-olds conformed to the findings of Fisher and Roberts (1980) and Sugarman (1979). Three-year-olds in these studies exhibited complex classifications involving stimuli which varied in three or more dimensions and the ability to shift from one class to the other. The objects utilized in the microworld software, although all the same color, were varied in size, shape, and function. Furthermore, children showed their ability to shift from one class to the other as they randomly placed objects inside or outside the house.

Finally, Gelman and Baillargeon (1983) noted that in some classification tasks the arrays contain two different classes of identical objects (Ricciuti & Johnson, 1965; Sugarman, 1979). In both of these studies children three and older, although more successful in producing complete spatial groupings of both classes of objects, also produced illogical groupings. These groupings usually exhibited some arbitrary one-to-one correspondence between classes. For example, the Sugarman subjects put a doll inside each ring. Gelman and Baillargeon (1983) suggested that similar objects are easier for the preschool child to classify. The antithesis of this is that objects that differ a great deal may result in less classification and more building or designing responses. Based on these conclusions, one might have predicted that the children in this study would have been tempted to create "pleasing spatial configurations" with the highly dissimilar objects used in the software and in the posttest. To an extent this did occur as several children were observed to make interesting, totem-pole-like structures on the monitor screen by piling graphic objects on top of one another. However, no "building" behaviors occurred during the posttest and as noted the microworld 3-year-olds performed significantly better than most of the other children. It can be argued, therefore, that this microworld proved itself a powerful method for presenting preschool children (age 3) with classification concepts in an artificial environment related to their experience wherein cognitive structures were developed.

CHAPTER VI

CONCLUSIONS

In summary a number of conclusions can be drawn concerning mother/child dyads, preschoolers, and microcomputers.

Children and Computers.

First of all, it can be concluded, although mostly from personal observation, that the children in both groups enjoyed their computer experience. Not one child acted the slightest bit ambivalent towards coming each day (in fact most had to be coaxed to leave). None of the mothers showed any ambivalence either. They often juggled their schedules two and three times in order to be available at their appointed time. Day after day mothers would tell the experimenter that this experience, be it microworld or ABC, was all their 2- or 3-year-old was talking about. At breakfast, lunch, and dinner, the topic of conversation for four days was the "computer." Some children even had to call their grandmothers to tell them all about the computer. Even children who could not talk had some way to represent the computer. One 18-month-old in the ABC group could barely talk. Nevertheless, he made a little growling noise with which he referred to the computer. His mother decided the growl stood for Stickybear and after observing the child growl each time Stickybear appeared, the experimenter concurred.

Mothers are Teachers.

It can be concluded that mothers were entirely capable, even with minimal training, of teaching and working with their preschool children at the computer. Considering the software differences, somewhat complex to incredibly easy, mothers behaved very much as predicted. Mothers paid a good deal of attention to their children and adjusted their interventions from cues based upon the children's successes and failures with the software. Mothers adapted remarkably well to the different situations they were exposed to. Mothers in the microworld group used considerably more verbal instruction and pointing. Mothers in the ABC group had less rigorous software with which to deal and consequently did less intervening. When they did intervene they tended to use verbal instruction. These software differences were closely related to why mothers in the microworld relinquished more control over software operation to their children as time progressed. Mothers in both groups emerged as competent teachers of computer literacy skills to their own children.

It can be concluded that the mothers in this study did not pay close attention to the "region of sensitivity to instruction." Again, software differences seemed to have influenced this. Microworld mothers had more to deal with and that explains why the ABC dyads experienced significantly more success with the computer. It was simply easier to cope with the software in that group.

Software and Interaction.

It can be concluded that the type of software utilized had tremendous impact on interactions between mother and child. Microworld dyads interacted considerably more as evidenced by greater amounts of verbal instruction, ongoing change in overall strategy, and children's dependency upon mothers in early stages of the intervention. Children learned to work independently at the computer rather quickly with the ABC software.

Age of First Introduction to the Computer.

In spite of Barnes and Hill's (1983) warning that "children must reach the stage of concrete operations before they are ready to work with microcomputers" (p. 11), 3-year-olds in the microworld group did surprisingly well. They showed the greatest task persistence, the least frustration, experienced greater amounts of software-operative success, and learned to classify significantly better than 2-year-olds and nearly significantly better than 3-year-olds in the ABC group. Microworld 2-year-olds, on the other hand, classified no better than children in the other group. They also exhibited more frustration, less task persistence, and the least software-operative success.

It has been well documented that young children between the ages of 18 and 48 months can learn computer literacy skills of varying complexity. DiRenzo (1983), Reed (1983), and Lawler (1982b) have shown that children 18 to 36 months can learn such skills as turning the machine on and off, match numbers between the menu and keyboard to make program choices, punch keys to "drive" graphic objects or hit targets, and type in words to manipulate graphics. However, most of these skills were gained after extensive preparation and more than 3 hours of instruction. Others (Borgh & Dickson, 1983; Shade et al., 1984; Muller, 1983) have shown that children between 4 and 5 learned similar and more complex computer skills. Such children not only learned to "boot a disk" and to change disks but hardware functions as well. This study, however, is the first to compare two age groups of children and different software formats.

Based upon these findings, it can be concluded that age of first introduction to the computer is dependent upon software content and competencies required. Highly colorful, cartoon-like graphics that respond to any key manipulation such as used in the ABC group require little preparation, instruction, or specific computer literacy skills. If a child can push a key, a child can operate this type of software with a high degree of success. On the other hand, software with exploration-oriented content that requires sequential manipulations of several keys requires particular competencies. Such software demands much of the child both cognitively and physically (fine-motor skills).

Therefore, it is recommended that 2-years of age and upward be considered an appropriate time to introduce children to the computer and teach simple computer literacy skills such as turning the machine on and off, making choices within software limitations, and simple graphics manipulations. Software to accomplish this task should be chosen with the goal of providing a pleasant, positive, and non-frustrating experience for the child. Single-key-operated software such as that used in the ABC group is perfect for this task.

It is further recommended that 3-years of age be earmarked as the appropriate time for increased computer literacy training and the introduction of discovery-based microworld software. It has been shown that children in this category are capable of increased sophistication in terms of content as well as keyboard manipulations. Children can now begin to explore the numerous concepts they have formed from their everyday environmental explorations.

In light of these conclusions it becomes necessary to warn professionals and parents of those who would claim greater computer sophistication and skills for children younger than 24 months (Langway et al., 1983; Stout, 1983). Programs that introduce young children to software beyond their ability to comprehend and operate run the risk of creating a generation of users frustrated before age 3. On the other hand, programs that do little more than let infants randomly punch keys and watch bright lights flash on the screen (all in the name of learning contingencies) are overdoing a simple concept that can be quickly learned at 2 as a prerequisite to more meaningful computer experiences.

<u>Microworlds</u>. Based on the superior performance of 3-year-olds over 2-year-olds in the microworld group and their nearly superior performance over the ABC 3-year-olds, it can be concluded that microworlds have great potential for enhanced cognitive development. If further research supports this trend, the implications for children's development are staggering. As pointed out by Ziajka (1983), "someday

we may want to add computer-generated images on a screen as a new form of representation that the child evokes and manipulates (p. 66)." He adds this possibility to an already long list of potential computer-based benefits to children. His list includes development of fine-motor skills, eye-hand coordination, symbolic representation, autonomy or a sense of control, social interaction, language development, and finally an active versus passive disposition. Although some would argue that preschool children of this age group cannot benefit from the "abstractions" presented by the microcomputer (Barnes & Hill, 1983), the trends emerging from this study argue otherwise. It appears -- and further research is needed to substantiate this point -- that 3-year-olds in this study benefited from computer abstractions. Of course, the difference was that the abstractions presented via computers were objects with which the children had dealings everyday and as such they were not far removed from their actual experiences. This feature is critical to the formation of microworlds and distinguishes them from other software formats. Papert (1980a) has stated that microworlds should be "syntonic" or adaptive to the social or interpersonal environment. In other words, an idea is powerful for a person if it relates and unifies knowledge gained in diverse experiences (Lawler, 1982a). Microworlds are powerful ideas because they contain phenomena which relate to the person's experience and embody the simplest model that an expert can imagine as an acceptable entry point to richer knowledge (Lawler, 1982a). As such they incorporate much of what Piaget (1970) and others (Ginsburg & Opper, 1978) have identified as essential to cognitive development: opportunities to explore and consequently assimilate and accomodate to new cognitive structures. As Piaget (1971) has stated:

> If we desire to form individuals capable of inventive thought and of helping the society of tomorrow to achieve progress, then it is clear that an education which is an active discovery of reality is superior to one that consists merely in providing the young with . . . ready-made truths to know with. (p. 259)

Furthermore, Papert (1980b) is certain the microcomputer will stimulate cognitive development by greatly increasing the number of relevant experiences in a child's life. Expose a child to 500 four-legged animals via a highly salient microworld where the child, through keyboard control, can manipulate the concept, and who knows what may happen? Yet, the slight evidence produced by this study is just a shadow of things to come. On the other hand, it must be pointed out that these findings may represent nothing more than a chance occurrence. The end result of the current emphasis on computer research (Brady & Hill, 1984) may prove the computer to be no more powerful than a pencil. Even if that is so, research in computer applications to young children will have helped to develop a powerful educational tool that makes few demands and gives much (Papert, 1980a).

In light of this possibility, it is relevant to outline the several redeeming qualities of microworld software. First of all, this software was "handmade" by the author using a Sprite/LOGO parallel interface care for Apple IIe. It took less than five days to do the required programming. Obviously, such a hardware/software package has great potential for microworld development. If the three-dimensional features of sprites and LOGO to manipulate them were utilized, microworlds could be tailor-made for any child or group of children. This brings up a second point: microworlds could be developed that would require groups of children to work together, practice, and develop social interaction skills. Evidence has already been cited (Borgh & Dickson, 1983; Church & Wright, 1983; Jewson & Pea, 1983; Muller, 1983; Nida et al., 1984) which showed the presence of a microcomputer in a preschool classroom facilitated social interaction. Furthermore, based on the work of Doise, Mugny, and Perret-Clermont (1975), in which nonconservers working with conservers showed marked cognitive advancement, microworlds could also be developed.

Thirdly, based on the evidence presented herein, microworlds could be utilized in testing and teaching classification. The same software designed to teach classification in this study could be used to test for it as well. Children could be taught to manipulate the objects following the four-step program previously outlined and then be presented with the house/yard microworld. Children could be allowed to "play" until finished and then the orientation of the objects could be recorded. In terms of teaching classification much has already been said. However, the potential of the microworld is unlimited. A microworld could be designed to teach classification as simple as equivalence judgements or as complex as Piaget's class inclusion task. The ability to tailor this software to suit specific needs makes it a powerful educational tool (Papert, 1980a).

Recommendations for Further Study

Data coding: Continuous. As previously explained data coding should be done by mother intervention rather than in 5-second observe/record intervals. Using the operational definitions concerning the start and end of interventions provided by Wood and Middleton (1975) (see Chapter III) one could code continuously, breaking to record as interventions change. This would ensure contiguity between mother and child behaviors and make possible use of the "sensitivity to feedback" score. As it was, during the 5-second record interval subjects would change what they were doing. The mother might decide on a different goal for the child or the child might begin some other activity. These occurred so often as to make it impossible to say, with any reliability, that behaviors from interval to interval on the score sheet were related. It should be pointed out that this presented no problem for mother and child behaviors within a 5-second interval.

Data coding: Mother behaviors. Two particular mother behaviors emerged in the microworld group. A mother would often remove her child's hands from the keyboard while trying to demonstrate and when banging and slapping of the keyboard was occurring. This behavior was easy to confuse with another more prosthetic behavior. In such cases the mother would surround the child's hand with her own and then go through the steps necessary to make the software function. For future research it is recommended that prosthetic behaviors be included as demonstration and that removal of children's hand to prevent computer damage be coded as no intervention.

<u>Future research: Increased Power</u>. Several procedures are available to improve the study by increasing the power to detect significant differences (Keppel, 1982). First of all, a larger sample size is needed since one of the simplest ways to increase power is to increase sample size (pp. 78-79). The addition of 10 more subjects in each cell of the 2x2 ANOVA would increase power to .86 which is well over the rule-of-thumb suggested by Keppel.

Keppel has suggested another way to increase the sensitivity or power of an experiment. He suggested increasing the length of treatment. If effects are present, then increasing the treatment amplifies the effect. Children in this study spent one hour, (four 15-minute sessions) at the computer. A future experimenter would have no trouble committing mothers to participate for an extended period. Mothers in this study (personal observation) were willing to change summer vacation plans, hire babysitters, and alter daily schedules in order to give their preschool child a computer experience. Eighty-nine percent of the mothers contacted agreed to involvment. Only three of those failed to keep their commitment. In other words, mothers were of the opinion that involvement with computers was a golden opportunity for their children -- hence, their positive answers on the questionnaire towards computers as a part of preschool curriculum (over 90% were in agreement) and their willingness to attend. There is no way to predict how much of an increase in treatment would be necessary. A logical approach would be a factorial design. One could vary the treatment times and investigate when treatment begins to be effective. Such a question was attempted in this study (repeated measures), and from the results it can be concluded that four days was not enough. From all appearances mothers in this study would have easily agreed to a two-week involvement.

One final method for increased sensitivity has yet to be highlighted. The strength of the treatment effect has been underscored by the fact that power to detect differences was less than or equal to .53. Keppel (1982) has suggested that replication alone can be a powerful way to investigate trends. He and others (Bronfenbrenner, 1979) have noted that no better evidence exists than replicated findings. Researchers, according to Keppel, too often accept preliminary or first-time findings as gospel truth. When effects are replicated across subjects, conditions, and treatments, then causal relationships are evident (Bronfenbrenner, 1983; Keppel, 1982). When the same or similar effects emerge time and time again, one can be certain the null hypothesis is false. This certainly is possible regardless of how low power may be. An effect's continued emergence testifies to its strength.

Future research: Microworlds. Once these findings have been strengthened and replicated, other questions can be asked. For example, once the microworld has been proven as an effective way to teach particular concepts, then it should be compared to traditional methods. Is the microworld a better way for children to learn classification skills, is it just as good, or are the traditional methods better? Can a mother with a doll house and similar objects teach her child to classify? Can teachers in a classroom situation do better or worse?

Many underrate the microcomputer's educational usefulness (Barnes & Hill, 1983; Brady & Hill, 1984) while others have a tendency to overrate its potential (Bell, 1983). Before these questions can be answered, such comparisons must be made.

Future research: Interaction. From the findings cited herein one can see that the microworld fostered dyad interaction whereas the ABC software did not. Even if the microworld never emerges as a boost to cognitive development, it can still be used to facilitate parent/child interaction. The list of topics that parents can explore and concepts that can be manipulated, exercised, and learned together is endless. Future research must consider the potential of the microworld to foster positive learning experiences for parent and child. It has been well established that the microcomputer is a facilitator of interaction in the classroom (Borgh & Dickson, 1983; Church & Wright, 1983; Jewson & Pea, 1983; Muller, 1983; Nida, Shade, Lipinski, & Watson, 1984). Why should it not function the same in the home?

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APPENDIX A

POSTTEST MATERIALS

Posttest Instructions

1. The posttest administrator will meet one hour before treatment begins (8:30 am) on each Friday of the four treatment weeks to receive the posttest schedule for that day. The posttest administrator will remain blind to the treatment group differences.

2. The posttest administrator will meet the mother/child dyad for the first time at the conclusion of their last treatment session. After being introduced by the experimenter the posttest administrator will say the following: HELLO (child's name) WOULD YOU LIKE TO PLAY SOME GAMES WITH ME WHILE YOUR MOTHER FILLS OUT SOME PAPERS? GOOD! LETS GO TO ANOTHER ROOM WHERE I KEEP MY GAMES.

3. The posttest consists of a dollhouse divided into five rooms. It has a roof and three sides but no front. Outside the house is a yard made of green material.

4. The posttest administrator is required to memorize the following to be said after directing mother to fill out the questionnaire:

HERE IS A HOUSE WITH FIVE ROOMS. LETS COUNT THEM (count). HERE IS A YARD WITH LOTS OF GREEN GRASS. THE ROOMS ARE INSIDE THE HOUSE AND THE GRASS IS OUTSIDE THE HOUSE. CAN YOU TOUCH A ROOM INSIDE THE HOUSE? CAN YOU TOUCH THE GRASS OUTSIDE THE HOUSE? GOOD!

NOW, LETS PLAY A GAME CALLED ´INSIDE/OUTSIDE.´ I WILL GIVE YOU AN OBJECT THAT BELONGS INSIDE OR OUTSIDE THE HOUSE. YOU GET TO DECIDE WHERE THE OBJECT GOES AND THEN PUT IT THERE. SOMETHINGS WILL GO INSIDE THE HOUSE (point) AND SOMETHINGS WILL GO OUTSIDE THE HOUSE (point). LETS START. HERE IS A (posttest administrator pulls an object randomly out of a paper sack). WHERE DO (object) GO: INSIDE THE HOUSE OR OUTSIDE THE HOUSE (posttest administrator hands the object to the child)?

The posttest administrator will continue until the child has placed all ten objects somewhere in or around the house. The posttest administrator will record the number of times each child correctly places a given object where it belongs. Children are allowed to change their mind and given credit for self-correction. However, if mother is unable to keep busy with the questionnaire and prompts the child, no credit is given.

5. When posttesting is complete the posttest administrator will thank the mother/child dyad, escort them out of the building, and return for another dyad.

6. The above testing procedure was tested and modified on 23 preschool children aged 18 to 42 months. No child was unable to understand the questions or instructions.

Parent Questionnaire

Please answer the following questions as accurately as possible.

1. Do you own a television?

____yes

____no

____how many?

2. Approximately how many hours a week does your family watch television?

____hours a week

The following four questions apply specifically to your child involved in the computer experience.

3. How many hours a week does this child watch television?

____hours a week

4. How many hours a day does your child watch educational programs such as Sesame Street, Mister Rogers, etc.?

____hours a day

5. When this child watches television, is there usually an adult present?

____always

____often

____seldom

6. At what time does this child usually watch television (rank in order from 1 to 6, with 1 being the most usual)?

____weekday afternoons

____Saturday mornings

____weekday evenings

____weekend evenings

____Sunday mornings

____other (please specify________________________________)

7. Do you own a microcomputer (personal computer)?

____yes

____no

If you answered "No" to question #7, skip to question #18.

8. How long have you owned your personal computer?

____less than 6 months

____6 months to 1 year

____1 - 2 years

____2 - 3 years

____over 3 years

9. What brand or type of personal computer do you own?

____Apple

____Texas Instrument

____Atari

____Radio Shack

____Osborne

____Commodore

10. Why did you buy a computer? (check all that apply)

____Business

____Home finances/record keeping

____Family entertainment

____Children's education

____Children's entertainment

____Curiosity

____Other (Please specify____________________________)

11. What does your family do most with your computer?

____Games

____Education

____Finances/records

____Word processing

____Other (Please specify____________________________)

12. How many hours does your family spend around the computer?

____hours a week

The following five questions apply specifically to your child enrolled in the computer experience.

13. Does this child interact with the computer?

____yes

____no

14. If yes to #13, how many hours per week does this child spend at the computer?

____hours a week

15. How strongly do you encourage this child to play with the computer?

____a lot of encouragement

____moderate encouragement

____little encouragement

____is not allowed to use computer

16. What educational software do you own for this child?

17. How strongly does your child like the computer?

____very much

____moderate

____somewhat

____not at all

Skip to question #19

18. If you answered "No" to question #7, do you plan to purchase a computer in the near future?

____yes

____no

19. My child's favorite after-school activities are:

20. Please use the following scale to rate your child:

1 Very much like my child

2 A lot like my child

3 Somewhat like my child

4 Not much like my child

5 Not at all like my child

____Easy to get along with

____Cooperative

____Manipulator

____Very bright

____Anxious

____Cooperative

____Aggressive towards toys and/or other objects

____Friendly

____Plays alone a lot

____Aggressive towards peers

____Inquisitive

____Spends a lot of time with adults

____Often seeks help from adults

____Likes to play with tinker toys, blocks, Legos, etc.

____Leader within peer group

21. Do you as a parent think that computers are appropriate in a preschool curriculum?

____yes

____no

22. Do you think computers can benefit children at this age?

____yes

____no

Score Sheet for Microworld

Posttest

Child:____________________

Date: ____________________

****

Objects: Place a check (/) if correct, a cross (X) if wrong.

Inside - TV ____

- Potty ____

- Bed ____

- Lamp ____

- Table ____

Outside- Swing ____

- Sign ____

- Car ____

- Slide ____

- Fence ____

TOTAL CORRECT:________

APPENDIX B

PILOT STUDY WORDS

List of Objects Pilot Tested

1. Inside Objects

bathtub

bed

books

chair

clock

clothes

couch

desk

lamp

radio

rug

sink

stool

stove

table

TV

2. Outside Objects

bicycle

bird

bug

car

cow

fence

flower

horse

lamp post

mailbox

pig

rabbit

sandbox

slide

squirrel

swings

tree

truck

APPENDIX C

PARENT PERMISSION LETTER

Dear Mothers:

This letter is written to request that you and your preschool child participate in a computer research and child development project during the week of .... to .... at ..... o:clock in room 225... of the Business & Economics Building, UNCG. No computer interaction will be available on Mondays; therefore, you will only need to come on Tuesday through Friday of the week indicated above. Guest parking is available in the Business & Economics parking lot and in the Administration lot across Sterling Street. The limit in these spaces is one hour which is more than adequate. Participation in this study involves a hands-on computer experience for you and your child. Children will be videotaped while interacting with the microcomputer for later data coding.

The primary purpose of this research study is to find out whether very young children (twos and threes) can learn to work effectively with microcomputers and age-appropriate software. Age-appropriate software makes the computer accessible to the young child by requiring skills they have or can easily master. An example of age-appropriate software was present at the Toddler-two Center the last day or two of school. You will recall that it required nothing more of the child than single-key manipulations. Specifically, the questions being posed are:

(1) Can a very young child, aged 18 to 40 months, learn to work with a microcomputer?

(2) Are certain kinds of software more accessible to the young child?

(3) Is the microcomputer an effective way to teach young children simple concepts and classification skills?

The timeliness of this research has recently been debated in both the national press and in scholarly publications. Much has been said of both a "pro" and "con" nature concerning the benefits of the computer to young children. This study will, through systematic data collection, make it possible to address these issues.

Because children of such young ages are being studied, it is necessary to ask mothers to participate. However, I wish to make it clear that mother's role will not be one of babysitting but rather teaching. Although it is true that the children will require some help in manipulating the software in the beginning, more importantly they need coaching from someone acutely aware of their interests and abilities. Past research has shown that no one can do this better than mother. Finally, it is necessary to provide the children with a secure base from which they can feel free to explore the microcomputer.

Data collection will begin on Tuesday, May 29, 1984 and will end on Friday, June 22, 1984 (we're getting started later than anticipated). The method used in this study is simple. Each mother and child will be given the opportunity to work with the microcomputer for a one hour period. This will be divided into four 15 minute sessions, on four consecutive days, all within the same week. Half of you will have the opportunity to work with software that teaches ABC's and half will explore classification concepts. Participation in these groups is randomly assigned for experimental purposes. Children will be videotaped and given a posttest to ascertain the effectiveness of the computer involvement. On Fridays please allow an additional 15 minutes for administration of the posttest.

To help with this research, I would appreciate your completion of the attached permission form and return mailing within three days (return postage reimbursed). You may phone your permission in early to assure a place for your child but the permission form still needs to be returned. If you desire a summary of the findings, please check the appropriate box on the consent form. Let me remind you that your participation in this research project is strictly voluntary with no penalty for withdrawal. In addition, all information will be kept strictly confidential. Any questions you have regarding this research will gladly be answered.

Sincerely,

Daniel D. Shade
Children and Technology Project (CAT)
Department of Child Development and
Family Relations
University of North Carolina
at Greensboro
379-5736

Parent Consent Form

Date:__________

My child, __________, may (_) may not (_) participate in the computer project entitled, In Mother's Lap: The Effect of Microcomputers on Mother Teaching Behavior and Young Children's Classification Skills.

I would (_) would not (_) be interested in receiving a summary of this projects results.

name:____

street:______________________________________

city/state:__________________________________

APPENDIX D

EXPERIMENTER INSTRUCTIONS

Instructions to Experimenter

1. The experimenter will be responsible for daily equipment checks, weekly data collection schedules, and weekly posttest schedules.

2. The experimenter must arrive at the Business & Economics building observation rooms (225a & 225b) at 8:30a.m. At this time all hardware, including the videotape cameras, will be checked to make sure they are functioning. Rooms will be prepared and the experimenter will be ready to greet mother/child dyads as they arrive at 30 minute intervals.

3. When dyads arrive the experimenter will greet them, show them to the computers, give instructions on operation to mother (first day), and one or two seconds after mother and child begin to manipulate the computer leave the room. The experimenter will then go directly into the observation booth and activate the videotape equipment. The experimenter will remain there until the 15 minutes are up at which time s/he will turn off the camera, go back to the treatment room, and inform the mother/child dyads that their time is up. Dyads will be thanked for their participation and reminded of their appointment the next day.

4. The following instructions are to be given to mothers in the microworld group:

This is an Apple IIe microcomputer with software specifically designed to teach the concept of inside/outside. Pushing the keys with pictures on them and then the "Go" button will cause a corresponding graphic object to appear in the neutral area on the screen. Pushing the arrow keys will cause the object to move forwards, backwards, right and left a preset distance. Pushing the "Stop" button will cause the object to remain where you have placed it and allow you to call up another. Pushing any other key will have no response.

There are 5 objects that belong inside the house (TV, Potty, Lamp, Table, Bed) and 5 that belong outside the house (Swing, Stop Sign, Slide, Car, Fence). Your job is to help your child learn how to operate this software. Would you like a practice trial or two?

5. The following instructions are to be given to mothers in the ABC group:

This is an Apple IIe microcomputer with software specifically designed to drill the alphabet. Pushing any letter key will cause a corresponding graphic symbolization to appear on the screen. There are two picture for each letter key. Pushing other keys will have no response. Your job is to help your child learn to operate this software. Would you like a practice trial or two?

6. After giving instructions to dyads the experimenter will say:

I have some work to do in another room and will return in about 15 minutes.

APPENDIX E

CODING MATERIALS

Instructions to Coders

1. Videotape coding will be done in room 102 Stone building. Coders will avoid discussing their observations until after the data coding period is over. Coders will work simultaneously under the direction of the head coder.

2. The duties of the head coder will be to coordinate the coding sessions. This will include operation of the VHS videoplayers, operation of the cassette player, and reliability checks.

3. Data coding will be done according to the revised Wood and Middleton Problem-solving Scale (1975). Data coding will be done in intervals of five-seconds on and five-seconds off. A 15-minute tape recording that signals every 5-seconds will be provided. Coders will watch the video, listen to the tape, and respond to instructions to observe and record. Each coder will have a headphone set to listen to the audio and an earphone for the 15-minute observation tape. In this way they will be unable to hear what the other is coding.

4. Reliability checks will be made 20% of the time without the coders' knowledge. When necessary, as indicated by the reliability checks, coders will meet with the head coder for additional training to

maintain reliability. Furthermore, in order to maintain a high reliability, all tapes for the microworld will be scored and then the ABC group. Since the software used in each treatment represent two of the major divisions (drill & practice and problem-solving), scoring one and then the other will control for error by eliminating the need for coders to switch back and forth between paradigms.

5. Coders will be separated from one another and the head coder by a movable partition. This is to prevent coders from viewing each other as well as seeing what the head coder is doing. Such procedures allow the head-coder to switch tapes as necessary for reliability checks.

Behavior Review List

Mother Behaviors

0) No Intervention: no computer-centered teaching or goal established for the child

- -mother may spend the 5-second interval doing nothing at all
- -conversation
- -child wanders around the room
- -non-computer-related teaching such as the ABC's, tracing letters on the screen, etc.

1) Mother Verbal Instruction: any verbal instruction or question, general or specific, that pertains to the computer or establishes a computer related goal for the child

- -naming the picture keys
- -reviewing the steps for software operation
- -what are you doing?
- -can you push one of the ABC keys?
- -where do you want it to go?
- -can you do it again?
- -can you find the potty?
- -can you make it go down?
- -no, you need to push a picture key
- -show me the "up" key

-now push the "go" button

-keyword - [TALKS]

2.) Mother Indicates Materials: further clarification of goal by narrowing the field of choice for child. Usually accomplished by pointing and/or touching

-mother pointing to a key, or keys

-mother points to the general area in which the correct key can be found

-mother waves hand over a particular set of keys

-mother touches a key but does not push it

-mother points at screen

-mother points while teaching

-keyword - [POINT/TOUCH]

3.) Mother Demonstrates: a specific goal (or set of subgoals) is selected and demonstrated by the mother

-a goal: placing the "car" on the grass

-a subgoal: pushing the "car" key just once, pushing the "go" key, pushing the down arrow until the "car" is in the grass

-any key manipulation by mother

-mother acts as a prosthetic device by placing her hand over the child's hand and then demonstrating a behavior; in the process mother may or may not actually press a key with her child's finger

-mother pushes the child's hand away from computer

-keyword - [DO/HELP DO]

Child Behaviors

0) No Child Success: any behavior on the part of the child that does not include correct manipulation of the software with the end result being the movement of a graphic object (microworld) or changing the screen picture (ABC group). Such behaviors would include random key pressing, banging the keys, slapping the keys, looking around the room, and wandering around the room. These behaviors will be scored zero.

1) Object Orientation: whenever the child is successful at placing an object (car, slide, lamp) in its correct place (inside, outside) or deliberately presses a specific key to obtain a particular screen graphic, success will be scored by indicating which object or key was correctly manipulated (see score sheet for abbreviations). It will further be indicated if either of the above were mother-directed or child-directed. This will be accomplished by adding a C for child-directed and a M for mother-directed after the object or alphabet abbreviation. For example, if the child was successful at placing the "car" outside the house, s/he would receive a CRC score. If the child correctly orients the "car" under mother's direction than a CRM would be

recorded. For children in the ABC group, either an AC or an AM would be recorded for deliberately pushing the "A" key.

2) Key Manipulations: it will be recorded whenever the child correctly performs any other key manipulation. These behaviors will also be qualified as child-directed or mother-directed. For example, if the child correctly pushed the "slide" key and then the "go" button (evidenced by the appearance of the slide in the neutral box), or moves an object around the screen by way of the arrow keys, a 1C or 1M would be recorded depending on who initiated the manipulations. It is possible for the child to receive a 1C by not following the mother's instructions. For the ABC group, any correct change of screen graphic would qualify.

Important Definitions

Mother Intervention. When the mother directs the child either by word or action toward some task activity or goal.

Intervention Termination. 1) When the child attempts a new or different activity or in any other way changes what s/he was doing. 2) When the child is not moved to action by the mother's suggestion and the mother moves on to suggest a new goal or operation. However, where the mother continues to request the same goal but with different instructions the intervention continues until such time as the child acts (see No. 1) or a new goal is suggested by mother.

REVISED WOOD & MIDDLETON
ASSISTED PROBLEM-SOLVING SCALE

MOTHER BEHAVIORS: 0=no intervention 1=verbal instruction 2=indicates materials 3=demonstrates behavior
CHILD BEHAVIORS: 0=no success 1=success/object orientation 2=success/key manip. C=child directed M=mother directed

Minute 1

Mother						
Child						

Minute 2

Mother						
Child						

Minute 3

Mother						
Child						

Minute 4

Mother						
Child						

Minute 5

Mother						
Child						

Minute 6

Mother						
Child						

Minute 7

Mother						
Child						

Minute 8

Mother						
Child						

OBJECT CODES

TV=television
BD=bed
TB=table
LP=lamp
PT=potty
SW=swing
SL=slide
SS=stop sign
CR=car
FN=fence

ALPHABET CODES

A,B,C etc.

NOTES AND COMMENTS

Minute 9

Mother						
Child						

Minute 10

Mother						
Child						

Minute 11

Mother						
Child						

Minute 12

Mother						
Child						

Minute 13

Mother						
Child						

Minute 14

Mother						
Child						

Minute 15

Mother						
Child						

OBJECT CODES

TV=television
BD=bed
TB=table
LP=lamp
PT=potty
SW=swing
SL=slide
SS=stop sign
CR=car
FN=fence

ALPHABET CODES

A,B,C etc.

NOTES AND COMMENTS