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An Exploration of Cognitive and Metacognitive Performance with COGNET MLE Treatment and No Treatment Control Students

Martha McBrayer Jones
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To the Graduate Council:

I am submitting herewith a dissertation written by Martha McBrayer Jones entitled "An Exploration of Cognitive and Metacognitive Performance with COGNET MLE Treatment and No Treatment Control Students." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Educational Psychology.

Donald Dickinson, Major Professor

We have read this dissertation and recommend its acceptance:

Kathy Greenberg, Bob Williams, Tom George

Accepted for the Council:
Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Dr. Donald Dickinson, Major Professor

We have read this dissertation and recommend its acceptance:

Katherine H. Greenberg

Robert L. Williams

Norman W. Brody

Accepted for the Council:

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Associate Vice Chancellor and Dean of the Graduate School

AN EXPLORATION OF COGNITIVE AND METACOGNITIVE PERFORMANCE WITH COGNET MLE TREATMENT AND NO TREATMENT CONTROL STUDENTS

A Dissertation
Presented for the
Doctor of Education
Degree
The University of Tennessee, Knoxville

Martha McBrayer Jones

May 1994

DEDICATION

I wish to dedicate this research study to my husband, Bobby. Without his support this would never have seen fruition. I also dedicate this research to my children, Rob and Bonnie, who have endured when they would have rather been playing. I am also indebted to my parents Marie Fitzgerald McBrayer (1919-) and Matt McBrayer, III (1916-1989) for encouraging me to find a profession and grow in it.

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I am also appreciative of the COGNET research staff for their support in helping pull together data for analysis. I thank Cynthia Gettys for her willingness to assist with the information about the COGNET implementation and appreciate her caring and supportive spirit. I also thank Glenn Bottoms and Bill Acker for their untiring support during parts of the statistical analysis.

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ABSTRACT

This study investigated the effects of the Cognitive Enrichment Network (COGNET) mediated learning instructional approach, an approach based on Feuerstein's theory of structural cognitive modifiability, on cognitive and metacognitive variables. COGNET and control subjects were in grades K-3 and were from two schools in rural Tennessee. They were identified as potential subjects by being former Head Start Participants, receiving free lunch, or by teacher referral for at risk status. They participated in the study for two years. Students were videotaped during the pre- and post-test administrations of the *Cognitive Functioning Analysis Instrument*. From these videos, the cognitive phase durations of "think time," "solution time," and "reflective thinking" were timed. In addition, the frequencies of metacognitive behaviors of requiring prompts, being off task, and monitoring were analyzed.

Using ANCOVA with the pre test as a covariate, think time and solution time did not differ statistically. COGNET students utilized reflective thinking more than did the control students. No significant differences between COGNET and control students were found on the metacognitive variables. The inconclusive results with the cognitive variables were viewed as a function of student variability and degree of teacher implementation of the COGNET program. The metacognitive variables occurred with

low frequencies.

These results suggested that the COGNET program did not develop strategies for problem solution on all cognitive variables. The COGNET group offered longer descriptions of their problem solving plan than did the control group; however, the duration measures may not have been entirely appropriate in the assessment of cognitive processing. The results did not support COGNET's effectiveness for improved efficiency in the metacognitive variables. The efficiency paradigm as hypothesized may be questioned since this is a group of at-risk learners. These results appear confounded by instrumentation, implementation, and age and developmental factors.

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CHAPTER I

INTRODUCTION

Tremendous changes in society, both scientific and technological, have prompted schools to examine their efficacy. The assessment has not been entirely encouraging. Some have maintained that America has one of the most expensive systems and yet produces the worst results (Mohar, 1992). With the advent of the technological and the information age, the schools' role has begun to focus less on teaching content for student memorization and more on helping students learn to apply knowledge in many situations to solve problems. Given that focus, instructional methods are emerging that foster the development of higher order thinking skills and independent learners. This research will compare the effects of **COGNET** (Cognitive Enrichment Network), an instructional approach based on Feuerstein's theory of Mediated Learning Experience (MLE), and a control group of primary school children. Effects on students' cognitive and metacognitive behavior while performing verbal and motor tasks will be studied.

As a cognitive education program, **COGNET** is a program that helps students learn and apply thinking skills and independent learning skills. These skills can be used across the content areas and in other aspects of life as well. In purpose **COGNET** reflects the direction that many educators and school improvement proponents have suggested. Jerome Bruner emphasized the importance of understanding the structure of a content area as one component of meaningful learning. This approach to education is called discovery learning and suggests that given the structure of a body of knowledge, students can learn how to learn as they learn.

COGNET contains both a metacognitive component and an independent learning skills component. **COGNET** can be used to support the use of Bloom's taxonomy of educational objectives by encouraging students to utilize information not merely know facts by rote. **COGNET** also supports the push for higher order thinking skills (Pogrow & Buchanan, 1985) by helping students understand and make automatic the processes used in learning. Armed with these strategies, students have more time to explore solutions. In addition **COGNET** involves students, teachers, parents, and others in the learning process and creates a supportive environment for learning. The commitment of a core of individuals increases the chances for reinforcement and transfer of skills.

COGNET differs from traditional approaches in the view that it has of intelligence. A brief history of intelligence offers an appreciation of the diversity of definitions and emphasizes the scope of the theory underlying the **COGNET** model. In history this concept has evolved from various metaphors. Sternberg (1990) classified historical and current views of intelligence by examining the underlying metaphor. Plato, in the fourth century B.C., proposed that the ability to learn was one aspect of intelligence and compared it to the metaphor of a ball of wax. Across persons, the ball of wax may differ. Within some persons, the wax may be small, pure, or plastic. Within other persons, the wax may be large, impure, or rigid. Believing in these individual differences, Plato supported the rule of the philosopher kings. In the thirteenth century, Aquinas described intelligence as a matter of degree; some can achieve more complete understandings than others. Later in the sixteenth century Montaigne described intelligence as knowing one's strengths and weaknesses. The variability of concepts of intelligence is apparent in the views of the ancient philosophers and is still debated.

Early in the twentieth century Editors of the Journal of Educational Psychology (1921) attempted to define the scope of intelligent behavior through a symposium entitled "Intelligence and its measurement." Fourteen contributors addressed the concept of intelligence, how it could be measured, and how research should proceed. A sample of their definitions included such qualities as adaptability, abstract ability, and the ability to learn from experience.

Some maintained that the definition was in a formative stage and would not state a definition. Again in 1986, Sternberg and Detterman solicited responses to the same questions. These responses of the contemporary theorists were framed according to the perceived locus of intelligence: within the individual, outside the individual, or both from within and outside of the individual.

Those who believe that intelligence was located within the individual addressed differences at a biological level, a cognitive-motivational level, or a behavioral level. Theorists believing that intelligence develops outside the individual, as a function of culture, define it as functioning in the environment and relate the concept of intelligence to a sociological metaphor. Theorists viewing intelligence as a blending or interaction of the individual and environmental aspects adopt a systems metaphor. The interactionists consider the individual difference aspects of intelligence and the individual's functioning within the cultural environment.

An example of a theory of intelligence focusing on what happens within the individual is the computational metaphor. As computer technology has advanced, the metaphor of the human mind functioning as a computer has flourished (Hunt, 1980; Brown and DeLoache, 1978). This computational metaphor describes a process by which an input is received by the computer, processed by the software program, and a response or output is created. The product of a computational process could involve changing the hardware, software, or changing the output format. Similarly the quality of a student report depends upon ability level, the mental process used to organize and generate the report, and the appearance of the final product. Any of these three areas can be targeted for changes to improve the final product.

The computational metaphor for analyzing thought processes to improve functioning suggests that with proper insight, persons can alter their methods to produce a better product. This type of approach might be classified as an information processing approach. Brown's information processing approach (1978) includes executive and non-executive processes. Executive processes are those skills that give students insight into the appropriateness of their proposed plan to achieve the specific learning goal. Non-executive processes are more automatic, having become routine with extensive practice. Using these processes, individuals can process any material through a series of inputs, processes, feedback loops, and outputs until the desired product is completed.

In contrast to the computational metaphor theorists, the sociological theorists acknowledge environmental contributions to intelligence. This view of intelligence seems a more recent development. A contemporary associated with the sociological view is Reuven Feuerstein (Sternberg, 1990), who believed in the plasticity of cognitive processing and developed a theory of structural cognitive modifiability (SCM). He maintained that individuals could modify their deficient cognitive processes by two processes. They could learn through direct involvement with the environment. They also could learn through MLE. Direct involvement may not be sufficient for learning if the information lacks meaning for the child. When direct involvement does not produce learning, then MLE can be helpful. With MLE the mediator, functioning as interpreter, assists by labeling, comparing, categorizing and establishing meaning that transcends the immediate needs of the situation. When students participate in MLE, structural changes occur that alter their approaches to situations or environments (Feuerstein, 1980).

In some aspects of his work, Feuerstein focused on immigrant adolescents who were being educated in different cultural surroundings. He found them to need more direction by persons skilled in interpreting their new environment. He found they did not understand how to adapt to the culture of their homeland either. Feuerstein inferred that because of the turmoil surrounding their lives, they needed more direction by persons skilled in interpreting the environment. With MLE these adolescents could become skilled at interpreting their environment and ultimately they could benefit from direct exposure.

Feuerstein not only recognizes the cultural contribution to learning with mediation, but he also recognizes the importance of the processes that individuals generate in cognitive situations. His focus on the processes and phases of learning and metacognitive factors and their potential for remediation through MLE suggests that this theory connects the individual theories of intelligence and the environmental theories of intelligence. This expanded view of intelligence and learning places Feuerstein's theory at the threshold of an interactionist's view (Sternberg, 1990).

Feuerstein's theory of SCM with components of direct exposure and MLE has proposed a means for helping "retarded performers" become more amenable to the learning opportunities offered. With this dynamic view, MLE helps these students tune into the specific aspects that are important to their successful learning, problem solving, and functioning within a very complex society. The students learn to attend to the metacognitive or "learning to learn" aspects of situations and gradually evolve into independent learners, thinkers, and producers in society. The MLE approach is an open system that recognizes the importance of both the process variables of learning and the product variables as significant to the assessment of ability.

Statement of the Problem

Researchers have measured the effectiveness of Feuerstein's remedial program, Instrumental Enrichment (IE), and MLE primarily by immediate achievement gains. IE studies have been conducted with adolescent students, this study investigated the processing differences with students of primary school age. Very little is known about the specific cognitive and metacognitive effects of participation in classrooms where MLE is incorporated across the content areas.

Purpose of the Study

The general aim of this study was to compare the **COGNET** and control students on the durations of cognitive phases and the frequency of metacognitive variables as they performed a series of minimally structured tasks. Researhers have proposed that as students become more experienced with task performance, they develop skills, plans, and strategies that make them more efficient. As students age they can be expected to become more efficient at task performance. It is hypothesized that both the **COGNET** and control students will show trends in the direction of efficiency, but the **COGNET** students will show accelerated trends because they had participated in the **COGNET** training. Given these hypotheses, research questions focus on cognitive and metacognitive processing of **COGNET** and control group students.

Research Question 1. Will the two groups change in the time allotted to problem solution? Several cognitive intervals will be considered. First will the two groups change in their "think time?" Think time corresponded to the duration that began after an administrator finished delivering the item and continued while the student was preparing to respond directly to the item. Think time can be thought of as response latency. As students become more efficient, their think time can be expected to decrease. The second phase was called "solution time" and corresponded to the duration when the student began their response either by giving a verbal response, pointing, or using the pencil to touch the paper of the stimulus item. Solution time concluded either when a plan description was begun or the administrator removed the stimulus item. As students become more efficient, their responses may become more automatic; therefore, solution time will decrease. Third, will the students change in the total time allotted to solution of any task? This total solution time was equal to the think time plus the solution time duration. Total time could be expected to decrease as students become more efficient. Finally will the students differ in their "reflective thinking?" Reflective thinking corresponded to the duration when the student began a verbal description of their plan and continued until the administrator removed the stimulus item, or began preparing to deliver the next item.

From this analysis of cognitive functioning, changes in students' problem solving performance may be studied from different phases of the process: as they plan to respond, as they are producing the direct response, and as they reflect on their method for solving the task. With the cognitive intervals determined, the frequency of the metacognitive behaviors can be counted.

Research Question 2. A second purpose of this study was to determine if the **COGNET** and control groups change on the frequency of metacognitive behaviors. There were three metacognitive variables studied. The first metacognitive variable was called "prompting." The prompting variable included the frequency of administrator prompts, redirects, or repeats of the question to facilitate the student's response. Fewer prompts might indicate greater independence in task completion. More prompts would indicate greater reliance on others in task completion. The second component of the metacognitive investigation was called off task and included a combined frequency of impulsive and off-task behaviors. Impulsive responding was defined as attempting to perform an item before the entire question had been delivered. Off task behavior was defined as the subject appearing distracted and diverting attention from the problem. A reduction in impulsive and off-task behavior may indicate greater self-control in the learning process. A third metacognitive variable involved a combined frequency of monitoring and clarification. Monitoring was defined by a student process of checking or rechecking their response by pausing to retrace, anticipate processing, or change an answer. Monitoring in the learning situation may improve cognitive functioning to a point that it may not be required with the developed automatic responses. Analysis of the student participation in a learning situation is similar to observation procedures that have been used to analyze teacher behaviors in the classroom (Sattler, 1990), but which use focuses on observable student behaviors. This type of approach aligns itself with the information processing and cognitive operation approach to learning and performance (Nickerson, Perkins, & Smith, 1985).

This study sought to evaluate the **COGNET** program through an efficiency paradigm. It is believed that the training will produce students who process information more automatically than the control group.

In summary, the present study investigated two questions. First, will the **COGNET** and control groups significantly alter the duration of three phases of problem solution? It is hypothesized that the **COGNET** students will significantly decrease the "think time" duration, significantly decrease the "solution time" phase of problem solving, and significantly decrease the total time allotted to task solution. It is hypothesized that the **COGNET** students will spend significantly more time in the "reflective thinking" phase than the control group. The reflective thinking phase is comprised of a response latency duration and a verbal description duration.

Second, it is hypothesized that the **COGNET** students will change their metacognitive strategy use. It is hypothesized that the **COGNET** students will significantly reduce the frequency of prompts and repeats of the question as compared to the control group. It is hypothesized that the **COGNET** students will significantly reduce the frequency of impulsive and off-task behaviors as compared to the control group. It is hypothesized that the **COGNET** students will significantly decrease the frequency of monitoring and clarification as compared to the control group.

Analysis of Data

Dependent variables with pre-test and post-test scores will be analyzed with ANCOVA using the pre-test measure as the covariate. Gain scores were computed to facilitate the comparison of group changes. For the reflective thinking variable, the post-test measures will be analyzed with a *t*-test for unequal variances.

Definitions of Operational Terms

For the purposes of this study, the following terms will be defined as:

COGNET is the acronym for Cognitive Enrichment Network. **COGNET** is an overlay program of workbooks and lesson plans developed to facilitate a mediated learning approach to instruction and enhance cognitive enrichment. The staff members of **COGNET** were responsible for providing the training and supervision for the research described in this document.

IE is the acronym for Instrumental Enrichment which is a program developed by Reuven Feuerstein and his colleagues. This program is designed to help students improve their capacity to profit from the direct exposure to stimuli.

LPAD is the acronym for Learning Potential Assessment Device. It is an instrument developed by Feuerstein and his colleagues to assess students' performance around seven parameters of the Cognitive Map: content, modality, phase, operations, level of complexity, level of abstraction, and level of efficiency.

MLE is the acronym for mediated learning experience which is defined as the "interactional processes between the developing human organism and an experienced, intentioned adult who by interposing himself between the child and external sources of stimulation, `mediates' the world to the child by framing, selecting, focusing, and feeding back environmental experiences in such a way as to produce in him appropriate learning sets and habits (Feuerstein, 1979, p.71)." MLE is thought to enhance cognitive functioning.

Phase of problem solving refers to the different stages that a learner goes through to solve a problem. Feuerstein refers to the three phases as input, elaboration, and output. For the purposes of this study, we refer to think time, solution time, and reflective thinking.

Reflective thinking refers to the last phase of problem solution where the learner summarizes the plan they made for answering the problem. It represents the duration of time beginning when the test administrator asks the student to describe their plan for working and continues until the administrator removes the test material for that item.

SCM is the acronym for structural cognitive modifiability. The term is used by Feuerstein to describe the internal changes learners make when the environment is interpreted for them by a skilled interpreter.

Solution time refers to the second phase of problem solution, and represents the duration from the beginning of the student's response, indicated by a verbalization, pointing, or pencil touching the paper of a test item, until the administrator asks for a plan description or removes the stimulus materials.

Think time refers to the first of the phases of problem solution. This phase corresponds to the duration of time which begins when the administrator finishes asking the question and ends as the subject begins their response.

CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter contains relevant literature pertaining to the study. A brief overview of metacognition is presented first, followed by brief reviews of the research on Instrumental Enrichment (IE) and the theory of mediated learning experience (MLE).

Overview of Metacognition

Producing effective instruction in the schools is one goal of education. Correlates of effective schools have been developed and researched extensively (Levine and Lezotte, 1990). The teachers' role in providing effective instruction has received much attention (Porter and Brophy, 1988). The attention to the teacher's role has not produced results that are all positive (Brandt, 1992). Teachers have felt pressure to document and verify their merit through improving student performance on measures of standardized achievement. Some have charged that teachers have been prone to "teach the test" (Gronlund and Linn, 1990). While dwelling on improving skills in standardized achievement tests, relevance, thinking skills, creativity, and problem solving abilities have been overlooked. In today's climate of technological change, the ability to transcend basic curricula and use higher level thinking skills may be essential to survival (Marzano and Arrodonda, 1986).

Approaches focusing on these higher order thinking skills change the role of both the teacher and the student. The teacher's role becomes more consultative as in cooperative learning, scaffolded instruction, cognitive coaching, and metacognitive explanation and modeling (Paris and Winograd, 1990). The new approaches require active participants in the learning and performance process. Some believe that increasing the student's role in education is important, even suggesting that the student's role is more important in determining what is learned than the teacher's role (Shuell, 1986; Sizer, 1991).

Changing from the student as passive recipient to student as active participant involves helping them to exert more control over their learning. This process of teaching students to "learn how to learn", metacognition, may have a positive effect on motivation and achievement. Metacognition is a powerful, comprehensive or intensified approach to thinking and learning about thinking. The research relating to this topic began in the 1960's from two different traditions. Flavell (1979 and 1985) had ties to the cognitive psychology of Piaget and analyzed problems of learning and performance based on the tetrahedral model (Jenkins, 1979; Bransford, 1979). This approach maintained that skilled performers differed from novices in their attention to: characteristics of the learner, nature of the learning activities, nature of the criterial task, and the nature of the materials.

A second approach to metacognition also began developing in the 1960's; both Flavell and Brown had reviewed the same information, but their focus was markedly different (Paris and Winograd, 1990). Brown and her associates (Brown, in Glaser, 1978) developed their approach from an information processing perspective, a view that used the computer as the metaphor for intellectual functioning. This approach was based on six factors: ability to determine conditions that could overload the capacity of the individual, knowledge and applicability of various strategies, ability to identify a problem, ability to plan and implement appropriate strategies, ability to monitor the strategy for effectiveness, and the ability to evaluate the strategy use. These factors include recognizing the utility of various strategies, recognizing when the system's limits would be overtaxed, and having the ability to recognize a problem and execute a series of possible solutions until the desirable end is achieved.

Both Flavell and Brown share the basic assumption that the learners' part in the problem solving situation is very important. Flavell's view suggests that individual learners are sensitive to the type materials, the task demands, and the nature of tasks used to measure learning or performance and can exert control over their performance by choosing to work through their areas of strength and avoid areas of less efficient functioning. Brown represents the learner as exercising control throughout the learning and performance process. Initially the learner determines if the response is within the system's limitations, then proceeds through strategy choice for execution, monitoring, and evaluation. Some have suggested that Flavell's view is teacher-centered while Brown's view is student-centered and student-driven. The unifying threads in both approaches are self-management and self-appraisal (Winograd and Paris, 1990).

The early work of Flavell and Brown provided the framework to approach the problem of analyzing student learning and performance to make personalized improvements. Such a framework also implied that a person's ability could be considered a dynamic rather than static element. From these initial views about ways to facilitate and improve learning and performance in children, many metacognitive and thinking skills programs have been developed. It is estimated that there are more than 500 such programs in use throughout the United States (Kruse, 1989).

Feuerstein's Theory of Structural Cognitive Modifiability

Feuerstein's view of the development of intelligent functioning is markedly different from the mainstream view. He sees organisms as dynamic and capable of changing in response to the needs of the situation. Intelligence is considered a "dynamic self-regulating process that is responsive to external environmental intervention" (Feuerstein, Rand, Hoffman, and Miller, 1980, p. 2). When an individual is not making satisfactory progress, the goal is to modify the individual <u>not</u> to change the environment.

This dynamic view differs from the conventional conception of intelligence as a static characteristic of a closed organism. While the static view may imply that persons are destined to play the hand of cards that they are dealt, the dynamic view entertains the position that learning and performance deficits can be overcome.

Feuerstein's theory of **structural cognitive modifiability** (SCM) is "directed not merely at the remediation of specific behaviors and skills but at changes of a structural nature that alter the course and direction of cognitive development" (Feuerstein et al., 1980. p. 9). Individuals fail to develop cognitively because they have been deprived of the process of learning how knowledge, values, and beliefs are transmitted. This void deprives them of the benefits of experiencing and understanding the process of transmitting culture from one generation to the next. In order for functional cognitive structures to develop, the individual can rely on two modalities: direct exposure and mediated learning experiences. Direct exposure occurs as stimuli are experienced independently. MLE occurs when an intentioned adult frames, filters, and schedules stimuli to make them more meaningful for the individual. Both are important; however, MLE can render an individual more receptive to learning through direct exposure.

The very absence of MLE is at the root of deficient cognitive functioning. To conceptualize the problems that the individual is having, difficulties in the three phases of the mental act must be considered. It must be determined if the individual has difficulty in the input of information, the elaboration of the information, or the output of the response. Besides these three phases of the mental act, affective and motivational characteristics of the learner need to be considered as potential troublespots in mental processing.

An additional component of Feuerstein's theory of SCM and MLE involves the **cognitive map,** an aid to the categorization and definition of the components of mental act. It is the basis for the analysis of the cognitive behavior of the retarded performer. There are seven parameters of the cognitive map. Content refers to the subject matter. Operations are the set of actions used to elaborate on stimuli. Modality refers to the manner in which the mental act is expressed. Phase refers to the three periods of the mental act, input, elaboration, or output. The phases of the mental act are of particular relevance in looking at the information processing and process variables in learning. The level of complexity may be understood as the quantity and quality of units of information necessary to produce a mental act. The level of abstraction involves the degree of distance between the direct experience of the phenomena and the manipulation of the information apart from the direct experience. The level of efficiency refers to the rapidity, precision, and the effort expended in the mental act. This concept of the cognitive map was the foundation for the Instrumental Enrichment (IE) program. IE is considered a useful remediation for deficient functioning. It is even considered a crystallized form of MLE.

IE was developed to promote and maximize the abilities of "retarded performers" (Feuerstein, 1980). This program is taught free of any content area. The materials have been used in a variety of countries: USA, Canada, South America, South Africa, Israel, and others. IE classes require 30 - 45 minutes three or four times a week. Covering the entire curriculum (15 instruments) may require two to three years.

The major goal of the IE program is to correct deficient functions. This goals is accomplished by assisting students in the acquisition of concepts, labels, vocabulary, and operations that improve performance. Participation improves the individual's ability to control their learning by producing intrinsic motivation, developing autonomous cognitive behaviors, increasing task intrinsic motivation, and developing deliberative and insightful cognitive processing.

The results from the research review of IE are equivocal. IE has been used with a variety of learners: hearing impaired, vocational program candidates, gifted, behaviorally disordered, disadvantaged, mentally retarded, and learning disabled. The results of IE with the hearing impaired adolescents have not produced clear cut results (Martin, 1983). Significant improvement for a group of adolescents was not shown on reading achievement tests or Raven's Progressive Matrices. Measures of the effect of IE on problem solving suggested that thinking processes did not generalize to other situations. The teacher observational ratings suggested that personal precision in completing tasks and cooperation had improved, and impulsivity had decreased. A second study at Gallaudet (Martin, 1984) with Educational Psychology students failed to show significant differences. A third study (Jonas and Martin, 1984) reported experimental group superiority in reading comprehension and math computation after the program had been implemented for two years. Other work with IE had been conducted at the North Carolina School for the Deaf with students 12-16 years of age (Haywood, Towery-Woolsey, Arbitman-Smith, and Aldridge, 1988). Math Applications did show significant gains over the control group. Teachers reported increased student cohesiveness and refinement of personal thinking skills (Johnson, 1988). These results with hearing impaired students appear inconclusive in documenting the effectiveness of IE with this population. Conclusions and comparisons are difficult to make since the both the length of treatment and the extent of the curriculum vary. Also these studies are compromised by small numbers of students, attrition, and differences in the IE instruments that were used. There may have been some differences in teacher implementation of the IE program as well.

Results with a three year study of vocational school students (Samuels, 1984) failed to document significant differences between experimental and control group students on measures of reasoning and intelligence, achievement, attitudes, and behavior. These teachers, like those in the Martin studies with the hearing impaired, expressed enthusiasm for the program and began to see students as capable of changing their thinking skills and not limited by mental deficiency.

IE has been used in cross categorical classrooms for exceptional children. A comparison of these adolescent students participating in IE and the Social Learning Curriculum (SLC) with a control group of mildly handicapped cross-categorical learners was conducted by Hall (1981).

Both curricula significantly outperformed the control group on response latency measures of the Matching Familiar Figures Test. No significant differences were noted on the Social Knowledge Assessment. The IE students significantly outperformed the SLC group on the General Information subtest of the Peabody Individual Achievement Test.

Another study with cross categorical populations was conducted in a public school setting (Perry, 1986). This study utilized one of the largest numbers of students of any of the studies reviewed. Over three hundred seventh and eighth grade students were involved. Nearly 200 students participated in the experimental group. After one year, the LD students had higher grade point averages than the control group. But, there is evidence that the results were confounded because regression analysis revealed that there was a significant effect for school attended. After two years, there was no difference between experimental and control group on measures of academic aptitude. However, LD students seemed to make more progress than EMH students on the Otis-Lennon and Peabody Picture Vocabulary Test.

IE research with LD students has involved some case study approaches (Messerer, Hunt, Meyers, and Lerner, 1984; Skuy, Archer, and Roth, 1987). These findings have supported the efficacy of the IE curriculum in remediating problem solving weaknesses, organizational skill weaknesses, and improving metacognitive behaviors.

Shayer and Beasley (1987) examined the effect of IE with 20 LD students. They concluded that IE does improve cognitive functioning and noted improvements of 1.5 years in problem solving abilities as compared to a control group improvement of .2 years. They concluded that IE may have greater effects on fluid intelligence than on crystallized intelligence as represented by achievement or content area activities.

Reviews of the literature on IE with various types of exceptional learners have produced equivocal results. Some have reported positive effects. Many have had difficulty maintaining appropriate experimental designs. Problems related to small numbers of participants and attrition rates may have compromised the research and made the results uninterpretable (Jones, 1992). The Department of the Army conducted a review of the literature (Savell et al., 1986) and determined that many problems in conducting the research have made generalized statements impossible.

These problems have prompted some researchers to expand research and change the way programs relating to the theory of SCM and MLE are conducted. Gilg (1990) of Boy's Town USA has utilized the IE program extensively, insisting that one appealing aspect of the IE program is that a student's academic achievement does not influence the ability to perform the IE tasks. Students who are having difficulty with reading or math, for example, will not have to overcome skill deficits to complete the IE instruments. From providing IE to students, Gilg has noted improved academic and thinking skill performance and dramatic changes in the way the teachers conduct lessons. After the IE curriculum was completed, the teachers continued to build on the principles of MLE by incorporating them in the regular academic classes and throughout the Boy's Town setting.

Others have chosen to expand the use of MLE, viewing the free-standing nature of the IE curriculum as a liability. Some have felt that teaching thinking skills independently of a content area limits transfer of those skills to school curricula. Some researchers have felt that improvement might be fostered by using the MLE approach when providing instruction in the content areas. Consequently, many programs have been developed that encourage the use of the principles of MLE in content area classes.

Overview of Mediated Learning

MLE can occur naturally in the classroom and be part of the teaching style of untrained teachers. Feuerstein (1980) described eleven characteristics of mediated learning experiences. Although all the characteristics were important, three of these were seen as sufficient to characterize an interaction as MLE: intentionality and reciprocity, transcendence, and meaning. Subsequently Klein and Feuerstein have added two additional criteria that have major relevance in the provision of MLE in interactions. The expanded list for MLE interactions includes: intentionality and reciprocity, transcendence, meaning, feelings of competence, and regulation of behavior (Klein, 1985; and Feuerstein, 1985).

There is variety in these programs focusing on MLE as a component in the performance of learners. MLE was a factor in the cognitive functioning of young children in a kibbutz (Turziel and Eran, 1990). Their results support the view that lack of sufficient MLE is responsible for deficient functioning. Neither the factors of SES, mother's intelligence, nor poverty were sufficient to explain children's functioning. Effective mediational styles appear to improve the cognitive ability of children. These findings validate Feuerstein's contention that insufficient MLE is the cause of cognitive deficits rather than low SES, poverty, or handicapping condition.

The belief that overcoming the problem of transfer that seemed prevalent in IE could be accomplished by teaching thinking skills in the content area led some to develop programs that used MLE. The **COGNET** program focuses on the provision of MLE in the regular classroom. It incorporates strategy development instruction as well as having teachers maximize their use of mediated learning by attending to eight parameters: intent, responsiveness, affective value, transcendence, mediation of meaning, mediation of self-regulation, mediation of a feeling of competence, and mediation of goal directedness (Greenberg, 1990). An assessment of the initial implementation of **COGNET** revealed some encouraging findings. First, the implementation of the first year of the project was studied in detail. Gettys (1990) found that during the initial year of implementation the teachers' attitudes toward teaching and their expectations of the level of student performance increased. The younger students' attitudes toward their own ability to learn to read were more positive than those of older and more able students.

This research effort has been analyzed to determine the differences between mediation of teachers trained in the **COGNET** model and those that were untrained (Greenberg and Woodside, 1990). Both trained and untrained teachers conducted lessons that were videotaped. The tapes were used for analysis. Four levels of mediation were differentiated. Level I represented the lowest level of mediation, and Level IV represented the highest level of mediation. These researchers found that **COGNET** teachers used higher levels of MLE than untrained teachers. A second finding was that **COGNET** teachers tended to exhibit behaviors conducive for high levels of mediation, such as asking process questions and using partially correct answers to expand a discussion. The untrained teachers tended to inhibit lower levels of mediation by asking for high frequencies of direct responses, and asking product questions. A third finding related to a commonality of **COGNET** and untrained teachers. **COGNET** teachers who exhibited Level II mediation were similar to untrained teachers who exhibited mediation behaviors at Level III. Furthermore, marked differences were noted between Level II untrained teachers, who used direct questioning of random students for recall of facts and offered praise and feedback, and Level IV **COGNET** teachers who asked choice questions and encouraged the student to complete the answers and continue to process the information until the responses were acceptable. These results suggested that the intent of **COGNET** to stimulate and promote higher order thinking was fulfilled.

A third study (Meyer, 1992) utilizing this intital **COGNET** implementation sample investigated the effects of the **COGNET** instructional model on the Tennessee Comprehensive Assessment Program (T-CAP). Data were available on a random sample of students consisting of 29 students from the experimental site and 28 from the control site. Statistical analysis revealed that the control group scores on the pre-test measure of the Stanford Achievement Test were significantly higher than those of the experimental group. The experimental group reading and math scores were 10 points below the control group's Normal Curve Equivalent (NCE) mean scores. NCE scores are normalized standard scores; they have a mean of 50 and a standard deviation of 21.06. During the study, the state had changed assessment instruments; therefore, the T-CAP was given as the regular part of the school assessment program in the Spring 1991 instead of the Stanford Achievement Test. Meyer noted the significant differences between experimental and control group on the pretest administration of the Stanford. She hypothesized that there would be no statistical difference between the groups on the post test with the T-CAP. At the conclusion of the study, the experimental group, the lower achieving group at the pre-test, had exceeded those of the higher achieving control group on the T-CAP. That comparison held except for those in Grade 1. Meyer (1992) concluded that the **COGNET** instructional model for teaching cognitive thinking skills improved academic performance.

Feuerstein's theory of structural cognitive modifiability (SCM) and MLE helps bring metacognition into the realm of student learning. This dynamic view offers the possibility of overcoming some problems that have been considered insurmountable: poverty, SES, and handicapping conditions. The cognitive map unifies the important features of the tetrahedral model and the information processing approach to cognitive functioning under the same umbrella. This theory addresses the importance of both the teacher and the student in the teaching and learning enterprise. In doing that, both curriculum and instructional initiatives are targeted for examination. In addition the learner is viewed as capable of contributing significantly to this enterprise. This view of the interaction between teacher and student and the personal contribution of each to the learning environment is worthy of investigation. Surely both are important players in achieving the necessary skills to reform education for the technological age.

CHAPTER III

METHOD

Participants

Subjects

COGNET Subjects

The **COGNET** project was funded in part by the U. S. Department of Education Follow Through program, Grant # 030913. The subjects in this study were part of a research study by Greenberg (1991) that involved students, teachers, and parents. Two elementary schools participated in the study. The administrative staff of the county in which the study was conducted identified these two schools as the most compatible on size, SES of students, and number of Head Start participants. Of the elementary schools in their county, these two schools had the highest numbers of students who had been former Head Start participants. They also had comparable percentages (15 - 20%) of free lunch recipients. Transfer rates from the schools were markedly different. The control group reported that 100 students per year transferred. The school secretaries attributed this to the presence of a four-year college in their town. As the college students completed their studies, many families moved from the area. The experimental site reported that 25 students per year transfer from their school.

Student subjects lived in a rural area of East Tennessee and were enrolled in two elementary schools in the Jefferson County Public School System. They were identified for the pool of subjects either through participating in the free lunch program, having been a former Head Start participant (60%), and/or having been identified by their classroom teacher at risk for academic problems (40%). Prior to the initiation of the treatment, 166 students were selected from each school, 78 were from the experimental site, and 88 were from the control site. Selection was based on socio-economic status indicators such as qualifying for free lunch under the federal guidelines, Head Start participation, teacher concern of low academic functioning, and/or at risk status.

The participating students, experimental and control, were in grades K-3. The average age of students at the conclusion of the study was seven years and four months. Students in the experimental group received the **COGNET** treatment as an overlay curriculum in their regular classroom. Students at the control site received their standard instruction. Since both schools were in the same county, the curriculum materials were comparable. Both groups were given pre-tests in the Fall. Students who transferred into the participating schools and who qualified, based on the same critera, were pretested each Fall. The post-test was administered at both sites in the Spring 1991.

Students were included in the study upon receipt of parental permission letter. Of the students who participated in the study, pre-and post-test data from the cognitive functioning analysis were available on 61 students, 39 from the experimental site and 23 from the control site. See Table I for demographic information.

TABLE I. Characteristics of the Children

	COGNET	CONTROL
Male	20	11
Female	19	12
Black	3	3
White	36	20
Grade K	15	9
Grade 1	12	6
Grade 2	7	3
Grade 3	5	5

Other Participants

Site Supervisor

The site supervisor of the **COGNET** project was a graduate student who had undergone more than 30 hours of training the first year and 50 hours of training the second year relating to Feuerstein's Instrumental Enrichment (IE) program, theory of Structural Cognitive Modifiablity (SCM), Mediated Learning Experience approach to learning (MLE), and the **COGNET** intervention program. She had some experience in delivery of similar material with groups of at-risk students. She provided regular, on-site supervision of the implementation of the **COGNET** treatment and assisted the Project Director with training as necessary. During the two years of the project, her involvement included visits every two weeks to provide technical assistance. During the last year monthly meetings were conducted.

Teachers

Thirteen teachers grades K-3 were trained to deliver the **COGNET** program. There were also 15 teachers (grades K-3) at the control site. Teachers at both sites had similar numbers completing graduate degrees and had similar ranges of teaching experience. Approximately 15% had fewer than ten years of experience. As certified teachers, all were identified as competent to undergo the training. Teachers at the experimental site attended the **COGNET** training course amounting to more than thirty hours of instruction during the first year of the program and 20 hours each during the second and third year of the project. Teachers had voted to participate and were not compensated for their participation.

Test Administrators

Graduate students affiliated with the **COGNET** project were trained to deliver the pre- and post-test cognitive functioning measures, which were administered individually. Besides the test administrators and site supervisor, an assistant handled testing materials, helped with the videotaping, and insured that students were available to be tested and returned to their classroom.

Overview of Methodology

Quantitative Design

The experimental design used in the study was a modification of the Non-Equivalent Control Group Design (Campbell & Stanley, 1966), a quasi-experimental design chosen because random assignment of the subjects was not possible. The assignment of schools to treatment condition was dictated by the fact that all staff from the Head Start Center serving one school had been implementing **COGNET** for two years. As a result, many children at that school had participated in **COGNET** for two years.

Independent Variable. The independent variable was the treatment variable. The experimental treatment was instruction with a thinking skills program called **COGNET,** a series of Cognitive Enrichment activities based on the theory of MLE. The **COGNET** school continued as an official part of the project for three years. Students who had been a part of the program for a minimum of two years (including Head Start) were included in this study.

The treatment involved making students aware of their thought processes and helping them learn to use that information to improve their performance. **COGNET** provided a series of 240 learning activities called Mini Lesson Plans (Greenberg, 1989a) for the teacher presentation, group and independent practice, generalization of thinking strategies (e.g., approach to task, thought integration, selective attention, and problem identification), and independent learning strategies (e.g., self-regulation, establishment of meaning, and self awareness). These mini lesson plans could be easily adapted to any type of lesson and content and could be repeated when appropriate. The lessons emphasized the use of components of metacognitive functioning within the curriculum. Using MLE in classroom and other settings allows teachers and parents to make children aware of the effectiveness of using **Ten Building Blocks of Thinking** and **Eight Tools of Independent Learning** (See Appendix A and B).

The control group was composed of a group of students selected based on the same criteria as the experimental group.

Dependent Variables. The dependent variables were chosen to assess the changes in cognitive and metacognitive behaviors, as students performed a series of verbal and motor tasks. Cognitive and metacognitive behaviors were assessed from videotapes of the students as they completed the *Cognitive Functioning Analysis Instrument*. Durations of the time students spent in the first two phases of learning and performance, think time and solution time phase, the cognitive component, of problem solution were recorded for eight of the items.

The metacognitive variables represented the independence and self management of students as they responded to the items on the *Cognitive Functioning Analysis Instrument*. The independence of students was quantified by counting the frequency of prompts given by the test administrator plus the repeats of the questions. Both the administrator prompts and repeats of the item suggested that the student required assistance to answer an item. The self management of students was quantified by the combined frequency of impulsive and off-task behaviors, as well as the combined frequency of monitoring, seeking clarification, or commenting voluntarily on performance.

Materials

Informal testing measures

The *Cognitive Functioning Analysis Instrument* was used as a pre- and post- test measure. It consisted of a collection of 13 informal tasks developed by the **COGNET** staff to observe students in problem solving situations. The tasks were open-ended items requiring both verbal and motor response modalities. The delivery of the items followed a prescribed order. Completion of the instrument required approximately ten minutes. Because these items were minimally structured items, no raw score for accuracy was intended. Eight of the items, four requiring verbal response modalities and four requiring motor response modalities, were chosen for analysis. See Appendix C for a testing protocol and sample stimulus items. Those items marked with an asterisk indicate those chosen for analysis.

Two additions were made for the post test administration of the *Cognitive Functioning Analysis Instrument*. First, an item was added that tested the students' memory. This item, entitled the Plateaux Test, was an item used in the LPAD (Feuerstein, 1979). The analysis of the memory performance was included to assess the students' performance on a well structured item; students cannot proceed without correctly answering each level.

The second addition in the post test involved the test administrator's asking the students to describe any plan they might have made for working. After completing specified items (items 2, 5, 6, and 8), the administrator asked if a plan had been made. If the student responded that they had made a plan, they were asked to describe it. The duration of this interval corresponded to the reflective thinking component of the cognitive functioning variable.

Observational Analysis Index

Coding of Student Videos

A systematic method of describing the students' problem-solving behaviors as seen in videos of pre- and post-test of the *Cognitive Functioning Analysis Instrument* was used. The Cognitive Functioning Observational Index was designed to simplify the investigation of the dependent variables (see Appendix D). Codes were established codes for the cognitive components, the three phase intervals think time, solution time, and reflective thinking. Codes were also established for the metacognitive components. The independence of the students' performance involved coding the number of times the administrator, prompted or repeated the questions. The metacognitive component also involved coding the student's self-directed behaviors: monitoring and clarification and impulsive and off-task behaviors.

Four categories of codes were developed to differentiate stimulus items on the test, the three phases of problem solving, student behaviors within the three phases, and test administrator behaviors. Each set of codes is described below.

Stimulus item codes. To specify behavior on different items on the pre- and post-test instruments, codes were assigned to each item. These codes were two letter combinations that reflected the content of the item. For example item number 3 depicted two girls racing, the item code for that question was RA.

Problem-solving phase codes. Using an information processing framework, operational definitions were devised for each of three phases. For the purposes of this study, the phases were named think time, solution time, and reflective thinking.

The think time interval (phase I) was the interval beginning when the test administrator finished delivering the question and ended when the student began a verbal or motor response (pointed or touched the stimulus item). This interval corresponds to the time the students plan before beginning a verbal or motor response. The code used to signal think time for all items corresponded to each individual question code (FP, RA, SM, CT, CP, WC, MZ, RC).

The solution time interval (phase II) began as the student started the response and continued until the administrator removed the stimulus item or asked if a plan had been made for working. This interval corresponds to the time the student takes to complete the response. One code identified the solution time; it corresponded to the AA code associated with each item. Because pretest data were not available for the reflective thinking phase, analysis of the change in this third phase was not possible.

The reflective thinking interval (phase III) began just after the test administrator asked the student to describe their plan and continued until the stimulus materials were removed. This interval involves the length of time the student took to verbalize the plan description. One code corresponds to the reflective thinking (DP) time for the specified items.

Student behavior codes. Operational definitions were also devised for particular student metacognitive behaviors that occurred as they proceeded through the three phases of problem solution. Seven student behavior codes were established to analyze the students' activity during the testing situation. The general framework for this set of codes was provided by Brown (1978). Codes and operational definitions were used to identify monitoring (MO) and seeking clarification (CC). An impulsive behavior was coded (IM) if the student began responding before the test administrator completed the question. An off-task behavior was coded (OT) if a student diverted attention away from the testing situation.

Administrator behavior codes. Since the student's behavior was of primary importance, it was necessary to create a series of two-letter procedure codes to account for the test administrator behavior, e.g., the delivery of the items, the manipulation of materials between questions, echoes of students' responses, or attempts to redirect the students to perform the correct response. Procedure codes were devised and accounted for the test administrators' preparation (AP), prompting (PT), repetition of question (RE), echoing of a student response (EC), request for plan description (PD), and subplan description request (SP).

With this system of codes, the duration of each phase of problem solving can be specified for each item. The test administrators' time can be omitted and the students' behavior within each phase can be described.

Manual Coding Form

This form was developed to simplify the recording of the codes while observing the videotapes. The form consists of a series of rows allotted to each item. Each row contains blocks for recording the phase codes or behavior codes. See Appendix E.

Timing the Phase Intervals from Student Videos

The timed durations of each phase of problem solution: think time, solution time, and reflective thinking were recorded from student videos. Using the problem solving phase codes of the Cognitive Functioning Observational Index, observers used a computer program to time the length of each phase interval.

Computer software. A software program for IBM compatible computers (Dickinson, 1988) was used to time the phases of problem solution. The timing program was a critical component in the examination of the changes in time allotted to the different phases of problem solving. The software allowed a series of exclusive 2 letter codes to be established and used to record durations of specific intervals. The Concept Teaching Observation Procedure Index that accompanied this software was not used. Instead the codes from the Cognitive Functioning Observational Index were used.

Procedure

Pre-Tests

Pre-testing with the *Cognitive Functioning Analysis Instrument* was completed by **COGNET** staff in the Fall of 1988.

COGNET Treatment

The experimental treatment began in the fall of 1988. The treatment was delivered within the classroom as a normal part of the instruction. The experimental treatment used a mediated learning approach to help students. It helped students understand specific processes that are important to effective thinking skills and management of their thinking and learning. Among the strategies taught were proper approach to tasks, importance of precision and accuracy in thinking, proper thought integration, the use of working memory, and others. Throughout the treatment, the participating classroom teachers used the Mini Lesson Plans (Greenberg, 1989a) to teach relevance of the **Eight Tools of Independent Thinking** and the **Ten Building Blocks of Independent Learning.** See Appendix A. The instructional situations were facilitated by the teacher, ensuring that student participants were completing the activities successfully. Each mini-lesson could be completed in brief time periods, typically three to five minute segments. Three or four short sessions could be conducted throughout the school day. Each daily sessions focused on the same Building Block or Tool, in some way connected two concepts, or related the daily activity to a Building Block or Tool. In addition teachers were encouraged to use bridging, generalization activities designed to facilitate transfer, as appropriate in the content areas.

The **COGNET** project (Greenberg, 1991) also involved a parent involvement and training component, linkages to health and human services, the addition of computer hardware and software in the third year of implementation, and variables that affected the teachers' delivery of MLE in the classroom. However, these were not addressed in the present study. Parents received training similar to that of the teachers without the emphasis on educational instruction. They were provided with a workbook describing ways of using mediated learning with their children in a variety of settings and situations (Greenberg, 1989c). Parents also attended workshops; contact hours amounted to approximately 16 hours per year. They also participated as members of an advisory board. The health and human services component involved arranging for screening of dental, vision, hearing, and general health conditions, linking families to needed services and providing transportation to some necessary appointments. Computers were added to the **COGNET** site during the third year of implementation. Twelve Apple IIe computers with dual floppy disc drives were provided to the experimental site. One computer was placed in each classroom. Groups of students used these computers for cooperative learning activities relating to specific curriculum needs. **COGNET** did not purchase software or provide software for use on these computers; however, they did offer the services of a computer consultant to answer questions about relevant software to serve specific instructional purposes.

Post-Tests

Post-testing with the *Cognitive Functioning Analysis*

Instrument was completed for experimental and control students in May 1991.

Pre-Analysis

Before any of the data were analyzed for this study, test administrators identified the predominant response modality for each item as either verbal or motor. There was 100% agreement of these administrators on the modality type. From these items, four of the verbal (FP, RA, CT, and RC) and four of the motor response items (SM, CP, WC, MZ) were chosen for the analysis of cognitive functioning.

Observer Training

Part I: Coding the frequency of cognitive functions. Training for the frequency count of student metacognitive behaviors was completed in three weekly sessions. The observers were told that one goal of this research was to describe the student behaviors as they solved a series of open ended minimally-structured items. The second goal was to time the intervals associated with think time, solution time, and reflective thinking time. The observers were given copies of the Cognitive Functioning Observational Analysis Index (Appendix D). The uses of the four different sets of codes were explained and defined. Item codes corresponded to each question. Specific codes represented the three phases of the problem solution. Student behavior codes could describe the behaviors within the three phases. Test administrator behaviors and preparation could be recorded. For example, the observation of each test session would begin by entering the code for administrator preparation as materials were placed and the item question was delivered. Entering each item code would signal the think time phase. Within this phase the students' behaviors could be recorded in sequence. The AA code signaled the beginning of the solution time and student behaviors could be listed in order of occurrence. The DP code represented the reflective thinking phase for those chosen items (RA, CP, WC, and RC). Using the student behavior codes the behavior in the reflective thinking could be documented. Raters were given copies of the manual coding sheet (Appendix E) and were instructed in the procedure for observing the videotapes and entering the codes. Using the codes described in the Cognitive Functioning Analysis Index, observers watched as the trainer viewed the videotapes of the testing sessions and recorded sequences of student and administrator behaviors for each item on the manual coding sheet. After this training session, observers then practiced independently prior to initiating the manual coding of problem solving functioning. Raters spent approximately 8 hours in training and independent practice. See Appendix E.

Observer reliability of frequency of cognitive functions. Observer reliability was assessed in the manual coding part of the data collection process. Reliability of observation of codes during training reached 85 per cent of agreement before the data were collected.

The assignment of tapes for each three raters was arranged by the Assistant Director of **COGNET**. Three tapes were randomly selected as reliability checks, and they were strategically inserted in the raters' lists to assess reliability throughout the five week coding process. Raters were not aware of the tape numbers that were selected as reliability checks, neither were they aware of the contents of the other raters' lists. Inter-rater reliability was established by having each rater paired with a different rater on three randomly selected tapes. When all lists had been completed by all raters, an inter-rater reliability check was performed by the Assistant Director of **COGNET**. Inter-rater reliability for all raters was computed as 80.12 percent of agreement.

Part II: Duration of phase intervals while problem solving. The second part of data collection of the **COGNET** project involved the recording the duration of the different phases in solving a problem: think time, solution time, and reflective thinking. This involved using the manual coding sheets and highlighting the codes for the think time phase (two letter item code), the solution time interval (AA), and the reflective thinking time (DP). When these interval discriminations were understood, the manual coding sheets could be used with the computer program to time the length of the intervals.

Initial training with the computer software was completed and the observers were given two weeks to practice using the program with the tapes and manual coding sheets. Two tape numbers were chosen at random and assigned for practice. Observers were instructed to practice using the program, complete duration analysis on the two tapes, and record timed intervals for 9 questions (four verbal, four motor) on the Phase Analysis--Timed Interval Sheet (Appendix F). After the two week period, the raters met to discuss any problems that might have been evident. Since the timing of the interval was the focus of this phase, some discussion of the criteria for the beginning and ending of the intervals was necessary. When a consensus was achieved on the problem areas, all observers independently timed yet another tape that had been randomly selected.

Observer reliability of the phase intervals. Observer reliability was also analyzed for the duration recordings. For the training of the three participating raters, the intervals were scored as in agreement when they were within .75 seconds of one another. Using this strict method of inter-rater reliability, the percent of agreement was 86 percent.

Once the initial reliability was obtained, each rater was assigned a list of tapes to complete in order. Each list contained three randomly selected tapes designed to serve as reliability checks. The reliability tapes were placed in the first third of the list, the middle of the list, and the last third of the lists. The lists were completed independently without knowledge of the duplication of twelve tapes. Analysis with ANOVA revealed no significant differences among the three raters on the reliability tapes.

CHAPTER IV

RESULTS

This study investigated the cognitive and metacognitive changes from pre test to post test for **COGNET** and control group students. Because the objective of this study was to investigate possible changes in cognitive and metacognitive performance as a result of **COGNET** training and there were significant correlations between the pre-test and post-test variables, the data were analyzed using ANCOVA, using each pre-test score as the covariate. The descriptive statistics are included in Table 2. To facilitate the understanding of the ways the two groups changed, the change scores are included in Table 2 and discussed throughout the section. A correlation matrix is included in Table 3.

Research Question 1. Will the two groups differ in their durations of the cognitive phases? The three cognitive phases were think time, solution time, and reflective thinking. First, will the two groups differ in their think time duration? The F-test of the cognitive dependent variable of think time was not significant, $F(1,1) = .02$ $p < .89$. It was hypothesized that exposure and practice of a number of strategies would enable the **COGNET** students to make automatic responses. This would mean that **COGNET** students would spend less time in the think time

TABLE 2. Pre-test and Post-test Means for Cognitive and Metacognitive Variables.

	COGNET (n=39)			CONTROL (n=22)		
	pre	post	change	pre	post	change
Think time						
M	53.60	44.97	-6.63	55.68	48.8	-6.88
SD	33.56	26.70	36.80	39.69	37.32	62.36
Solution time						
M	249.65[a]	257.89	8.24*	182.72[a]	267.31	84.59*
SD	114.76	86.92	140.20	62.36	76.39	85.26
(Total time)						
M	303.17[a]	302.11	11.06*	238.44[a]	316.11	77.66*
SD	122.82	91.15	151.07	60.29	88.75	96.95
Reflective thinking						
M		15.90		(latency)	11.33	
SD		16.84		(latency)	31.08	
M		29.23[b]		(description)	12.41[b]	
SD		31.02		(description)	15.40	
Prompts						
M	15.63[a]	15.00	-1.00*	19.74[a]	15.00	-5.00*
SD	4.08	4.68	5.91	8.21	5.86	5.66
Off task						
M	1.00	0.00	0.00	1.00	1.00	0.00
SD	.93	.96	1.14	2.00	3.24	3.43
Monitoring						
M	2.00	2.00	0.00	2.00	3.00	1.00
SD	2.55	2.74	3.11	1.76	2.87	2.61

[a] = statistically different at pre test, $p < .05$.; [b] = statistically different at post test, $p < .05$; * = change scores statistically different, $p < .05$.

TABLE 3. Correlation Matrix of Cognitive and Metacognitive Variables.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	
1. GROUP	1.0												
2. TTPR	.04												
3. TTPOS	.03	.42											
4. SOLPRE	-.27*	.01	-.18										
5. SOLPOS	.06	-.07	.10	.10									
6. REFLAT	-.14	.07	.28*	.05	.14								
7. REFDES	-.28*	-.16	-.14	.11	.04	.05							
8. PTPR	.31*	.36*	.46*	-.09	-.07	.14	-.19						
9. PTPOS	.001	.19	.29*	-.19	-.06	.25*	.10	.44*					
10. PTPRE	.12	.13	-.15	.03	.01	-.04	-.002	-.08	.007				
11. OTPOS	.17	-.14	.01	.07	-.07	.31*	.14	.17	.31*	.23			
12. MOPRE	-.15	-.16	.05	.20	.04	-.16	.02	.07	-.007	.09	-.09		
13. MOPOS	.06	-.15	.19	-.09	.01	.10	.16	.04	.16	.21	.25*	.33*	1.0

* $p < .05$

phase than the control group. Inspection of the data indicated that both groups reduced their think time duration from pre test to post test.

Reduction in think time by both groups could be expected. With maturation and experience, people develop skills, plans, and self-regulatory strategies which may improve efficiency in completing tasks (Brown and DeLoache, 1978). The expectation that **COGNET** would spend even less time than the control group was not supported. The think time interval was typically very short for both groups. Seventy-five percent (33 of 39) **COGNET** group spent less than one minute in think time throughout the post test. Those that exceeded a one minute cumulative duration, typically spent about two minutes in this phase. A similar pattern emerged for the control group. Eighty percent (18 of 23) of the control group spent less than one minute in think time throughout the post test. Short durations with similar variability for **COGNET** and control students did not produce significant differences.

The second cognitive phase was the duration of solution time. Will the two groups differ in their duration of solution time? The F-test with the pre-test score as a covariate was not significant $F(1,1) = 0.57$, $p < .45$. The prediction that **COGNET** training would reduce the duration of solution time as compared to the control group was not supported. Both the **COGNET** and control students increased their solution time; however, the average change score for the **COGNET** group, 8.24 seconds, was significantly different from the change score for the control group, 84.59 seconds.

The third cognitive variable involved the examination of the combined duration of the think time and the solution time phases. This seemed appropriate since both phases contribute to the final solution of the problem. An ANCOVA was done on the combined difference scores for total time, the think time plus the solution time. Refer to "total time" section of Table 2. The results of the ANCOVA were not significant at the .05 level, $F = .45$, $p < .51$.

The investigation of the third cognitive phase compared the **COGNET** and control students on their reflective thinking about their solution of the problems. This phase was measured in two ways: response latency on the reflective thinking and the duration of the verbal description of their problem solving. There was no significant difference between the two groups on the response latency of the reflective thinking phase $t = 1.27$, $p < .21$. Generally the duration of this interval was short. The average for the **COGNET** group was 15.63 seconds and the average for the control group was 11.32.

The second component of the reflective phase involved the verbal description of the students' plans for solving the problem. There was a significant difference between the **COGNET** and control groups in the duration of their verbal description of their plan $t = 2.67$, $p < .009$. The **COGNET** students averaged 28.48 seconds in plan description on the specified items. The control group averaged 12.41 seconds. These results suggest that the trained **COGNET** students were more aware of their strategies and more verbal in descriptions of their approach than the untrained control group. Observers noticed that **COGNET** students frequently used **COGNET** instructional terminology and phrases in their verbal description of their problem solution.

In short, there is little support that **COGNET** affected the cognitive processing in the think time and solution time phases. There is evidence that the **COGNET** students did spend significantly more time in verbal descriptions of the reflective thinking phase than did the control students.

These results do not give unqualified support for the **COGNET** model to help students become more efficient in cognitive processing. None the less, the observers watching the video tapes generally felt that the **COGNET** instruction had improved performance in many students.

Research Question 2. Will the two groups differ in their frequency of metacognitive behaviors? The three metacognitive variables were prompting, off-task responding, and monitoring. The first metacognitive variable involved a frequency count of the number of prompts that students required during the test. The ANCOVA using the pre test as covariate was not significant on the prompting variable

$F(1,1) = 1.56$, $p < .21$. All of the students required prompting to complete the minimally-structured items of the *Cognitive Functioning Analysis Instrument*.

The second metacognitive variable involved the change in the frequency of off-task responses. The ANCOVA using the pre test as covariate was not significant $F(1,1) = 1.37$, $p < .24$. Off-task responses were not exhibited by each child. About half of the **COGNET** and control students exhibited off-task behaviors at pre test. The low rate of this behavior by only half of each group may account for the failure to show significance.

The third metacognitive variable involved the change in the frequency of monitoring. The ANCOVA on the dependent variable of monitoring using pre-test scores as the covariate was not significant $F(1,1) = .27$, $p < .35$. The expectation that **COGNET** students would be more efficient and utilize well-practiced automatic strategies was not supported. At post test eleven **COGNET** students had monitoring frequencies of zero. In comparison only four of the control group students had monitoring frequencies of zero. Although the percentage of **COGNET** students using monitoring declined from pretest, the two groups were not statistically different. Certainly the low frequency of the monitoring variable made it difficult to produce significant results.

These results for the metacognitive variables show little significant change between the two groups. None of the ANCOVAs for the metacognitive variables showed significant differences at post test. The hypotheses that **COGNET** would become more automatic in their problem solving and would reduce the frequency of metacognitive variables was not supported. The change scores were significantly different between the two groups on the variable of prompting. However, the higher frequency of prompts on the pre test by the control students accounts for the significant difference.

In summary, none of the variables compared from pre test to post test produced significant results. The reflective thinking verbal description duration (these data were only available for the post-test administration) was significantly longer for the **COGNET** students. This supports the assertion that this training can help students become more aware of their own thinking processes and can provide students with meaningful methods to use in problem solving.

CHAPTER V

DISCUSSION

This study compared the cognitive and metacognitive changes of **COGNET** and no-treatment control students. It was anticipated that the **COGNET** students would become more efficient problem solvers. Having learned and practiced the **COGNET** strategies, they would reduce their cognitive durations and frequencies of metacognitive strategies on the minimally-structured items. There is little support that the **COGNET** and control groups differed on the durations of think time and solution time. There is support that the **COGNET** students had significantly longer durations of plan descriptions in the reflective thinking phase than did the control students. Because the **COGNET** students had been in classrooms where they were encouraged to work with incorrect responses until they had achieved a satisfactory response, they appeared to utilize the reflective thinking cognitive phase more than the control group. Anecdotal records from taped observations indicate the **COGNET** students often used the instructional terminology and concepts in their plan descriptions. There is no support that the two groups differed on the metacognitive variables of prompting, off-task behaviors, or monitoring.

There are some problems with this research that severely limit these results. This study represents a pioneering effort to look at the use of **COGNET** with young children and to look at their information processing from both cognitive and metacognitive perspectives. This seems appropriate since Feuerstein looks at the phases of the mental act in his Instrumental Enrichment (IE) program. Educators also see the merit of improving problem solving because it can provide their students with methods to approach difficult tasks efficiently and productively. However, these results have shown little to suggest major changes in cognitive and metacognitive functioning. Only the expectation that **COGNET** students would spend longer in the reflective thinking phase was statistically significant.

Several methodological problems exist which may influence these results. First, the variability in the data was extreme and may indicate that these hypotheses, intended to document efficiency in problem solving, were inappropriate. The same result was hypothesized for all participants. In approaching the evaluation this way, we may have masked the true changes that students made. As with some exceptional students, whose learning styles are highly individual, perhaps these at-risk students do not exhibit typical patterns in their problem solving behaviors. These hypotheses did not account for individual learning styles or strengths and weaknesses. Perhaps dividing the groups into quick responders and slow responders would have unlocked the key to the variability. Certainly this needs to be investigated with adequate sample sizes.

One can also question the appropriateness of these methods in the investigation of the metacognitive variables. This data collection process required that observers view videos of the students answering the minimally-structured items. Students were not required to describe their methods or processes as they worked on the items. Only after the students had completed their responses were they asked about the planning that they had done in problem solution. This method of retroactive verbalization was chosen so that the cognitive intervals would not be disturbed. However, it may not have been the best method for investigating the metacognitive variables. Other methods such as predictive verbalization or concurrent verbalization techniques may have provided more information for the metacognitive investigation.

Another methodological problem involved the fact that this research was conducted with two intact groups. Considering that the control group required less solution time at pre test, they might have answered the questions quicker because they were better at problem solving than the COGNET group. The equivalence of the two intact groups may be questioned. However, their performance was not necessarily due to greater efficiency. The evidence that supports this is that the control group required significantly more prompts at pre test than did the **COGNET** group. If the control group had been more efficient problem solvers, they would have required fewer prompts to complete the items. Furthermore, the pattern of lower solution time duration for the control group did not hold for the post test administration. The post-test comparisons of the two groups showed no statistical significance on think time or prompting. Given the pattern of lower solution time, greater prompts by the control group, and no statistical difference between the two groups at post test, it is difficult to suggest that the control group may have been more efficient at pre test.

Also related to the methodology issue is the appropriateness of using a latency and response-time measures as dependent variables. Both of these types of measures tend to have skewed distributions and may require some data transformation (Kling and Riggs, 1972). The use of these measures can make it difficult to separate out the dependent variable effects from the effect of the variable not being normally distributed. The distribution plots for these dependent variables did indicate that there were departures from normality, and thus it is difficult to interpret these results. In addition to the fact that duration recordings do not follow a normal distribution, there is also a problem that there is no known research relating to the changes in phase durations in cognitive functioning. The expectation that all students would change their durations in the same direction ignores what we know from learning style research and the research from the field of learning disabilities.

A second major problem in this study involves instrumentation. Although educators have begun to investigate the area of problem solving, the assessment instruments have not developed at the same pace. When the initial **COGNET** project was begun (1988), there was little available to assess problem-solving abilities. In the absence of reliable instruments that had been field tested, the *Cognitive Functioning Analysis Instrument (CFAI)* was developed and used. This instrument was used knowing very little about its reliability. This, of course, leaves these results highly suspect.

Students from kindergarten through third grade participated in this study. It is possible that the large age and developmental ranges of participants may affect performance on the assessment instrument (see Appendix G). The extreme variability in the data may be related to the age appropriateness of the *CFAI*. It has been suggested that the short durations of the kindergarten students may indicate that some of the items were too difficult for these students. They may have guessed at an answer to remove the discomfort of not knowing the correct answer and being unsure of how to address these minimally-structured items.

Performance seemed to differ across grade levels. If the kindergartners did indeed guess, there is the suggestion that some trends toward efficiency occur with **COGNET** group in grades 1 and 2. For example, the solution time interval increased by grade through the second grade. For both groups, the second grade students showed the largest change scores of any grade. The change scores of the control group showed a large increase at the second grade level, with positive change scores. In comparison the **COGNET** groups change scores showed a decrease in the duration of the cognitive intervals at this grade. The presence of the negative change score by **COGNET** students could indicate that participation in the program from first grade, at pre test, until the post test, near the end of second grade helped their performance on the minimally-structured items. Their solution-time durations decreased significantly from pre test to post test. Perhaps the assessment instrument was out of the range of the younger students and therefore only the older students were able to make meaningful efforts to solve these problems. If this is the case, the variability of the data could have been influenced.

Another problem with instrumentation involves the age and developmental appropriateness of the **COGNET** program. Perhaps our expectations were too high for the younger students. Work by others in teaching learning-to-learn skills have preceded the **COGNET** effort. Scientific reasoning has been studied with students in the concrete operations stage (ages 7-11) and formal operations stage (ages 12-15). Work with younger children is not common. The Marzano model was used in the Walla Walla School district in Washington (Arrendo and Marzano, 1986). In this program, learning-to-learn skills are taught throughout the primary grades, as are content thinking skills. Reasoning skills using elaboration do not enter the curriculum until the second grade. Perhaps the **COGNET** program was above the level of understanding for the younger children and this contributed to the variability in the data.

Inspection of these grade level findings by the triangulated rating of teacher implementation obtained by the **COGNET** site director (Gettys, 1993) helped clarify these variability findings. The **COGNET** teachers having the highest implementation scores taught in the first and second grades. In general, the lowest implementers of the **COGNET** program were teachers in the kindergarten classes. The third grade teachers were average implementers. In those grades where there was low implementation, the variability was not as great as in those grades where there were high implementers and average implementers. Thus part of the variability of the results may be related to the implementation level of the **COGNET** program. Further analysis of the performance of students who received average to high implementation was not conducted because the sample sizes for both groups would have been reduced by more than half.

The inspection of the raw data supported the assumption that some of the **COGNET** students did become more efficient problem solvers (see Appendix G). From looking at the data arranged by group and grade, a pattern of change emerged. Looking at the average duration of solution time showed steady increases in durations and positive change scores by both groups until the second grade. Those **COGNET** students who were given the post test at the end of second grade decreased in durations and had change scores with negative signs. Since implementation was highest at grades 1 and 2, this negative score could indicate that when the program was implemented to a high degree, first and second grade students do tend to become more efficient in their problem solution. The positive change scores that were typical of the control group do not show the trend to greater efficiency.

The attempt to measure the effectiveness of the **COGNET** program from an efficiency paradigm produced only one significant effect for reflective thinking. The failure of the **COGNET** program to produce significant changes in the other cognitive and the metacognitive variables may be a result of an inappropriate match between the hypotheses and the highly variable data, instrumentation, the wide variability in implementation of the program, or some age-related factor.

COGNET is a program that has expanded the ideas found in Feuerstein's Instrumental Enrichment (IE). The available research on IE program has not documented overwhelming statistical support. These results do not suggest that the **COGNET** program is ineffective. **COGNET** has just begun to be implemented and more is learned with every research effort. There may be certain ages at which the **COGNET** students can benefit optimally from this type of instruction. Perhaps as the younger students mature, they may utilize the information they learned to a greater degree. Other researchers have suggested that instruction of this type may be used and developed by students even after interventions have ended (Jonas and Martin, 1984; and Gilg, 1990).

While these results do not give overwhelming support for the **COGNET** program to improve the efficiency of the students, those who viewed the video tapes noticed that many students did become more confident and willing to attempt the items on the post-test administration. One student, who did not attempt to answer on the pre test, attempted every item on the post test. Many of the **COGNET** students seemed to internalize the concepts and terminology used throughout the **COGNET** program. Because of the change in the assessment instrument used by the administrative unit, the changes in the achievement data for these students is not available. There is evidence that others have found significant improvements in achievement test scores after having participated in the **COGNET** program (Meyer, 1992).

These results support the ability of the **COGNET** students to utilize planning for problem solution, as noted in the reflective thinking comparisons. There is the suggestion that methodological flaws, instrumentation, and implementation have influenced these data.

It is not time to abandon the **COGNET** program. This initial investigation in cognitive processing as assessed with duration and frequency recording may have taught little more than we can not expect all students to change and progress at the same rate. Inspection of the data suggest that in the grade levels where **COGNET** was implemented to a high degree, the changes in students' problem solving durations may reflect important changes in problem solving behaviors. However, the small numbers of students who received high implementation of the program prevented further statistical analysis of these data. Research should continue with the **COGNET** program delivered by competent teachers with adequate sample sizes.

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APPENDICES

APPENDIX A

10 BUILDING BLOCKS OF THINKING

The Building Blocks are prerequisite skills upon which thought processes are based. In the Mediated Learning Experience, the mediator (teacher or significant adult) evaluates the learner's level of competency and use of these Building Blocks and seeks to help develop those that are under developed.

Approach to Task. Beginning, being involved with, and completing an event, including gathering information, thinking about the situation, and expressing thoughts or actions related to the event.

Precision and Accuracy. Awareness of the need to automatically be exact and correct in understanding and using words and ideas.

Space and Time Concepts. Understanding basic ideas about how things relate in size, shape, and distance to one another (space); and the ability to understand measurement of the period between two or more events and/or changes that occur due to these periods (time).

Thought Integration. Pulling together and using at the same time multiple sources of information which are a part of a given event.

Selective Attention. Choosing relevant pieces of information when considering thoughts or events.

Making Comparisons. Awareness of the need to automatically examine the relationship between events and ideas, especially in determining what is the same and what is different.

Connecting Events. Awareness of the need to automatically associate one activity with another and use this association in a meaningful manner.

Working Memory. Enlarging the thinking space in order to enter bits of information from the mental act, retrieve information stored in the brain, and make connections among the information gathered.

Getting the Main Idea. Awareness of the need to automatically find a fundamental element that related pieces of information have in common.

Problem Identification. Awareness of the need to automatically experience and define within a given situation what is causing a feeling of imbalance.

APPENDIX B

8 TOOLS OF INDEPENDENT LEARNING

These tools are needed if a person is going to be an active generator of information and not just a passive recipient. They are described by Feuerstein as "parameters of mediated learning" and are included in the **COGNET** program under the following labels:

Inner Meaning. Being aware of and developing a significance inside yourself that provides intrinsic motivation for learning and remembering.

Self-regulation. Controlling your approach to learning by using metacognition (thinking about how you are thinking) to determine factors like readiness and speed.

Feeling of Competence. Knowing you have the ability to do a particular thing. Lack of this tool often results in laziness and other avoidance behaviors; presence of it results in feeling confident and motivated to learn.

Goal Directed Behavior. Taking initiative in setting, seeking, and reaching objectives on a consistent basis.

Self-development. Being aware of your uniqueness as an individual and working toward becoming all you can be.

Sharing Behavior. Communicating thoughts to yourself and others in a manner that makes the implicit explicit.

Feeling of Challenge. Being aware of the effects emotions have on novel, complex, and consequently difficult tasks: knowing how to deal with challenge.

Awareness of Self-change. Knowing that you change throughout life and learning to expect, nurture, and benefit from it.

APPENDIX C

Cognitive Functioning Analysis Instrument

Pre- and Post-Test Items--Level One

(Note: Words in parentheses indicate directions to the examiner to handle the materials for each item. Words in brackets indicate the expected number of parts for each item. Words in bold type are the verbal presentation made to the child.)

1. (Place card with geometric figures in front of child.) **Show me the black triangles.** (Are you sure?) [3]
2. **Tell me how to make a peanut butter and jelly sandwich.**

   (Did you think about it first?) [varies from two to many]
3. (Place figures of two running children in front of child.)

   ___________ and ________________ began a race at the same time. Tell me two reasons why ________ is in front of ___________. (Did you make a plan for working?) [two]
4. (place card with colored figures in front of child.) **Show me the small blue square.** (Are you sure?) [one]
5. **When were you born?** (did you think about it first?) [month, day, year--three]
6. **How many daughters does your mother have?** (Did you think about it first?) [one]
7. (Place card with pictures representing calendar times

in front of child.) **Look at these pictures. This is a week** (point), **and this is a day** (point). **One is longer than the other. Put the right rod next to the right time.** (Are you sure?) [two}

7a. **Why didn't you use this rod?** (Are you sure?) [one or more]

8. (Place card of associate pictures in front of child.) **Look at these pictures, some of them go together. Connect the pictures that go together.** (Wait until child has made all connections he/she desires, then ask question for each set of connections.)

8a. **Why did you connect each of these to each other?** (Did you make a plan for working?) [two or more based on appropriateness of child's rationale for sets of connections]

9. (Place picture of pots in front of child.) **Here is a picture of two pots. This pot is full** (point) **and this pot is empty. What happened?** (Are you sure? [one]

10. (Place card of animal pictures in front of child.) **Which of these live in the water?** (Did you make a plan?) [three - six depending on whether includes turtle, dinosaur and/or snake; must include crab, fish, and frog]

11. (Place maze in front of child.) **Here is a maze. The object of this game is to get from start** (point) **to**

the goal (point). **It is up to you to decide how to do that. This maze has four parts. At the end of each part** (mark 3 exits with X) **you can decide whether you want to stop and go in the goal, or continue through another maze. It is up to you whether you go through 1.2.3 or 4 mazes to get to the goal. Once you begin don't lift your pencil from the paper. If you come to a dead end, go back to where you made the wrong turn and keep going. Taker as long as you like. OK, begin here.** (Point) (Did you think about it first?) [see maze test for child, already scored]

13. (Place card with two different geometric designs in front of child.) Here are two pictures, A (point) **and B** (point). **How can I make picture A look like picture B?** (Did you make a plan for working?) [child must refer to removing one part of design an\or color as well as stating what to draw in its place]

APPENDIX D

Cognitive Functioning Observational Analysis Index

* Indicates item chosen for analysis.

(V) Indicates item with verbal response modality.

(M) Indicates item with motor response modality.

STIMULUS ITEM CODES

OS Black triangle--question 1.

*FP Peanut butter and jelly sandwich--question 2, (V).

*RA Race--question 3, (V).

*SM Small Blue Square--question 4, (M).

BD Birthday--question 5.

*CT Calendar time--question 7, (CT).

*CP Connect pictures--question 8, (V).

TP Two pots--question 9.

*WC Water category--question 10, (M).

MP Map--question 11.

*MZ Maze--question 12, (M).

*RC Red cross becomes circle--question 13, (V).

*LA Learning phase for plateau, post test only.

*MA Memory phase for plateau, post test only.

INFORMATION PROCESSING PHASE CODES

Think time corresponded to the two letter question codes for each item. See * items above.

* AA Solution time code is entered as soon as child begins a verbal or manual response.

* DP Reflective thinking code corresponds to the time that a student takes to describe the plan.

STUDENT BEHAVIOR CODES

* MO Monitoring is coded when students pause to check or recheck their response.
* CC Student clarification is coded when the student asks a question in response to a test item.

OT Off task behavior is coded when a student appears distracted and diverts attention from the problem at hand.

OK Student answers yes to the administrator's question prompts "Are you sure?", "Did you think about it?", "Is that what you meant?", or "Did you make a plan?"

It is an affirmation of the administrators statement.

* IM Impulsive response. Subject begins answer before the question is complete.

KO Student answers "NO." to plan description request. Student answers "I don't know" to a prompt question. Student negates an administrator statement.

* CV Voluntary comments about performance.

PROCEDURE CODES--TEST ADMINISTRATOR BEHAVIOR

AP Administrator prepares for delivery of the question.

* PT Administrator prompt e.g., "Are you Sure?" , "Are you thinking about your answer?", "Did you think about it first?", and "Did you make a plan for working?"

* RE Administrator repeats the question.

EC Administrator echoes the student response to a question.

PD Plan description request-- "What was your plan?"

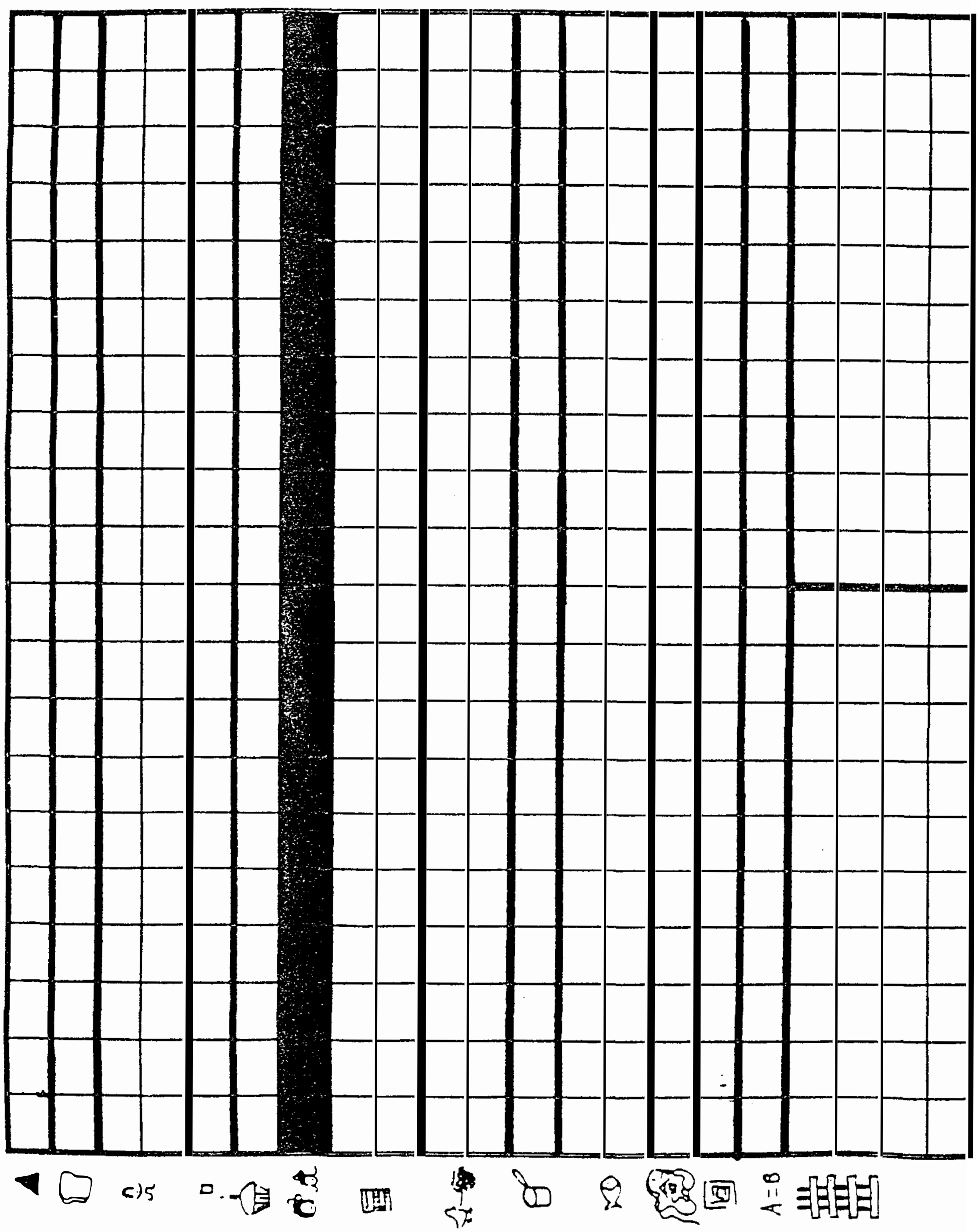
SP Sub plan explanation request (items CP and CT)-- Test administrator asks "Why connect these?", or "Why didn't you use this rod?"

APPENDIX E

Manual Coding Form

Observer's Name ____________________ Subject's Number __________ Code Number __________

Date of Analysis ____________________ Date of Video ____________ Tape # ______________



APPENDIX F

Timed Interval Form

OBSERVER NAME______________ DATE OF ANALYSIS____________

SUBJECT NUMBER_____________ TAPE NUMBER_________________

DATE OF VIDEO/EorO________ ADMINISTRATOR_______________

Code	Input/pt	Solution/pt	Reflection/pt
FP			
RA			
*SM			
CT			
*CP			
*WC			
*MZ			
RC			

APPENDIX G

Descriptive Statistics for Cognitive Variables by Grade.

		COGNET (n=39)			CONTROL (n=23)		
		pre	post	change	pre	post	change
Think time							
Grade k	*M*	40.74	45.94	5.19	69.71	59.92	-9.78
	SD	744.46	1012.74	477.44	2000.70	1981.42	2328.14
Grade 1	M	66.45	55.88	-10.57	48.01	45.56	-2.44
	SD	1857.84	834.99	2604.62	883.80	393.86	714.44
Grade 2	*M*	62.06	38.45	-23.61	52.02	28.93	-23.08
	SD	590.75	145.59	1123.22	307.20	9.61	211.23
Grade 3	*M*	38.79	31.25	-7.54	41.84	44.58	2.73
	SD	402.76	72.78	186.44	625.03	462.30	262.07
Solution time							
Grade k	*M*	179.73	228.20	48.47	189.95	248.14	58.19
	SD	7246.25	7229.52	8991.68	4122.27	4423.70	5175.48
Grade 1	*M*	230.54	272.59	42.04	203.67	228.18	24.51
	SD	8419.65	13550.36	21831.95	3328.01	2915.63	2979.26
Grade 2	*M*	391.02	251.57	-139.45	161.85	356.31	194.46
	SD	13388.80	7363.59	11635.92	2748.97	180.31	4334.18
Grade 3	*M*	257.39	268.98	11.59	187.32	287.48	100.16
	SD	8297.83	2860.84	15597.39	3508.59	6183.84	6622.95

VITA

Martha Marie McBrayer Jones was born in Marion, North Carolina on January 28, 1953. She attended public school in North Carolina. In 1975 she was awarded a Bachelor of Arts in Psychology from Wake Forest University. In 1978 she was awarded a Master of Arts in Education degree from East Carolina University, Greenville, North Carolina.

Mrs. Jones has been involved in various aspects of the educational system in North Carolina. She has worked in hospital-day program settings, institutions and community based programs for the developmentally disabled, and has worked as a public school teacher in regular and resource classrooms. She has served as liaison between schools and families and is presently employed as a guidance counselor in a middle school. She also serves as adjunct instructor at Gardner-Webb University. She was awarded the Doctor of Education degree in May 1994.