1996

Effects of homework prescriptions based upon individual learning style preferences on the achievement and attitude toward mathematics of sixth-grade students.

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EFFECTS OF HOMEWORK PRESCRIPTIONS BASED UPON INDIVIDUAL LEARNING-STYLE PREFERENCES ON THE ACHIEVEMENT AND ATTITUDE TOWARD MATHEMATICS OF SIXTH-GRADE STUDENTS

by

MARY ELIZABETH WHITE

A DISSERTATION

Submitted in partial fulfillment of the requirements for the degree of Doctor of Education in the Joint Program in Educational Leadership in the Graduate Schools of the University of Alabama and the University of Alabama at Birmingham

BIRMINGHAM, ALABAMA

1996

ABSTRACT OF DISSERTATION
GRADUATE SCHOOL, UNIVERSITY OF ALABAMA AT BIRMINGHAM

Degree Ed.D. Major Subject Educational Leadership

Name of Candidate Mary Elizabeth White

Title Effects of Homework Prescriptions Based Upon Individual Learning-Style Preferences on the Achievement and Attitude Toward Mathematics of Sixth-Grade Students

The primary purpose of this study was to analyze the effect of an individualized homework prescription on sixth-grade math students' achievement and attitude as compared to sixth-grade math students who used conventional study techniques. Two hundred twenty students in a suburban middle school in Alabama were selected to participate. One-half of the students were assigned to the experimental group and the remaining half to the control group. Academic ability within each group ranged from gifted to learning disabled or at-risk students. Due to the inclusion model, a concentration of LD students was found in the experimental group of Teacher 2. Achievement was measured using a criterion referenced test on algebraic equations. Students were administered two instruments, the Learning-Style Inventory (LSI) (Dunn, Dunn, & Price, 1991) and the Semantic Differential Scale (SDS), for purposes of diagnosing and prescribing learning style preferences and comparing students' attitudes toward two different homework techniques.

The data yielded no significant differences between the control and experimental groups in achievement or attitude due to the homework prescription. However, significant differences emerged between teachers when the instructional style of the teacher was

congruent to student processing style. Students in the classroom of Teacher 2 achieved significantly higher mean test scores (p <.05) than those in the classroom of Teacher 1. These findings indicated that the teacher's style of instruction is a confounding variable that must be considered in future research. The overall data support the contention that the teacher's instructional role within the classroom may overshadow the use of a homework prescription as it relates to achievement and attitude unless the teacher encourages study techniques complementary to student style through instructional modeling.

Abstract Approved by: Committee Chairman James E McLean

Program Director Boyd Rogers

Date 6/13/94 Dean of Graduate School Grant Lester

DEDICATION

This dissertation is dedicated to my family, Jim, Brad and Chad . . .My most avid supporters.

ACKNOWLEDGMENTS

Many ingredients bring to completion this doctoral investigation. Without the encouragement, constant support, and expertise of many others, this would not have been possible. My sincere gratitude is extended:

. . . to Mr. Bill Sparks, my Superintendent, and to Mr. John Draper, Principal, for their support.

. . . to Jane Walsh for her cooperation and patience in allowing me to modify her global style during the study!

. . . to my doctoral cohort for their continued friendship and inspiration toward the improvement of instruction for *all* children through learning styles theory and practice.

. . . to the members of my doctoral committee, Drs. Jerry and Jan Herman, Dr. Gypsy Abbott, Dr. Harold Bishop, Dr. Dave Dagley, Dr. Mary Ann Manning, and Dr. James McLean, for their constructive criticism and commitment during all phases of this study.

. . . to my dearest friends in the Faith Class, who offered friendship, love, devotion, caring, and faith, which sustained and renewed me during the most difficult periods.

. . . most especially to Dr. Rita Dunn, my mentor, whose professional inspiration, leadership and charismatic personality has been a continued instrument of guidance and

support in all my endeavors with learning styles. Her proactive involvement in research and her desire to promote academic excellence has provided additional motivation for the completion of this study—through her eyes I have seen that "children are not a vessel to fill but a torch to light for the future."

. . . and above all, this doctoral study is dedicated to my family—my parents, Wilson Cooper and Mary Josephine Chapman, who left me this legacy, that no task is so insurmountable that it can not be accomplished as long as you aspire to its completion with persistence and commitment and believe in yourself; my aunt Harriet, an educational role model; my children, James Bradley and Wilson Chadwick, for their patience and cheerfulness through difficult times. Had it not been for your help and belief in me, I would not have been able to fulfill this lifelong dream. My special gratitude to my husband, Jim, for his unfailing love, devotion, encouragement, and faith. Without the many sacrifices you have made, this most coveted degree would not have been possible. To you I commit my undying love.

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CHAPTER I

Introduction

The costs and consequences of the high number of at-risk and dropout students both in the United States and throughout the world have been a major concern for parents and educators (Dunn & Griggs, 1995). An analysis of the learning styles of many at-risk students, as well as those who have dropped out of school, has revealed that, within most classrooms, students feel they must live up to teachers' expectations while being instructed as if they had been extracted from the same mold. Many successfully hide their anxieties, yet others, potential drop-outs, verbally express that they do not like school (Dunn & Dunn, 1987). Dunn and associates found that when teachers modify and expand their instruction to respond to students' individual learning styles, increased achievement and positive attitudes result. Eminent learning specialists (Dunn, Dunn, & Treffinger, 1992; Dunn & Griggs, 1995) have provided evidence that an optimal learning environment for students involves the use of a processing style and of instructional strategies which match their processing style, a style that may be different from other people of the same age, class, culture, grade, religion, or nationality.

During the past decade, faculties at several 4-year colleges experimented with teaching students to do course assignments or to study for examinations with strategies directly related to each individual's learning style. Experimentation resulted in

significantly higher achievement test scores in anatomy (Cook, 1989; Lenehan, Dunn, Ingham, Murray, & Signer, 1995), bacteriology (Lenehan et al., 1995), marketing (Dunn, Deckinger, Withers, &Katzenstein, 1990), mathematics (Dunn, Bruno, Sklar, Zenhausern, & Beaudry, 1990), physiology (Lenehan et al., 1995), and across subjects (Clark-Thayer, 1987, 1988; Mickler & Zippert, 1987). In addition, overall grade-point averages and attitudes toward learning were significantly improved (Clark-Thayer, 1987, 1988; Nelson et al., 1993). Significantly reduced anxiety and anger scores and increased curiosity toward course content also were revealed (Lenehan et al., 1995).

Subsequently, Turner (1992) provided gifted fifth graders with similar guidelines for studying and reported significantly increased grades with treatments that were matched to learning style, rather than with those that were mismatched to learning style. A year later, Turner (1993) reported that teaching students about how they learn—their unique styles—served to increase both awareness of the instructional process and their own metacognition. At about the same time, Marino (1993) experimented with providing homework prescriptions for high school students by identifying their personal learning styles and suggesting complementary environmental, sociological, and physiological treatments that also considered individuals' emotional and processing-style characteristics. Although these researchers reported higher grade-point averages for college, high school, and elementary school learners who were taught to study with strategies that responded to their unique characteristics, the literature includes no similar experimentation with middle-school students—the population likely to respond positively to interventions that nurture and assist them during the changes that occur in their learning styles during adolescence (Dunn & Griggs, 1995).

Statement of Problem

Adolescence is a period of rapid biological change. Adolescents' need for sound (music or background noise) and intake (eating, drinking, or biting on objects) while learning reaches an all-time high. They often exhibit nonconforming behaviors and express strong needs for mobility and kinesthetic activities. Their sociological preferences change from adult (Parent and/or teacher orientations when younger) to strong peer orientations between 6th and 10th grade (Dunn & Griggs, 1995). These changes in learning style often require concomitant changes in recommendations for how students should study and concentrate on new and difficult academic information, a requirement that leads to the need for revised ways of doing their homework. Adolescents who are at risk for academic failure may experience difficulties with concentration on demanding subjects and they often drop out of school during this period; others become recalcitrant and/or lose interest in schooling. Others experience reduced self-concept and lower grades.

Previous research with elementary, secondary, and college students reported beneficial effects of using homework prescriptions to suggest unique ways for individuals to study and to complete academic assignments (Hodges, 1985; Lenehan et al., 1995; Nelson et al., 1993). The effect of homework prescriptions on the achievement of middle-school students has not been reported to date.

Purpose of the Study

The purpose of this research was to examine the effects of homework prescriptions based upon individual learning-style preferences on sixth-grade students' achievement and attitude toward mathematics.

Hypotheses

To address the questions posed, this study will test the following null hypotheses:

1. There will be no statistically significant difference ($p < .05$) in math grades between the sixth-grade students who have received and followed their personal learning-styles prescription and students who have not received a learning-styles prescription.

2. There will be no statistically significant difference ($p < .05$) in math grades between the sixth-grade students who have received and followed their personal learning-styles prescription and students who have not received a learning-styles prescription.

Significance of the Study

The ongoing international comparison of the math achievement of American students with students in other countries is likely to continue. It is important that the educators in the United States teach young people to become skilled in math and secure at each grade level and that these youth become receptive to the study of math in order to advance in courses required by modern technology. Thus, there is a need for research in the area of achievement and attitude toward math.

Research on learning styles reveals increased achievement with matching style-responsive methods and environments. It is possible that style-responsive treatments also may affect students' attitudes as well as their academic progress. In this study, the effects of teaching individuals differentially by providing information based on their learning-style strengths may arouse a new awareness in student learning. It also may provide insights concerning why selected students either involve themselves in, or refrain from involvement in, math by specifically scrutinizing the effects of matched and mismatched

instructional prescriptions on individual student's attitudes as they relate to math homework.

Assumptions of the Study

For the purpose of this study, the following assumptions were made:

1. It was assumed that the subjects' use of conventional study techniques or individualized homework prescriptions would remain constant for the duration of this investigation.

2. It was assumed that the subject matter, in and of itself, would not affect the treatment significantly.

3. It was assumed that the consistent use of the same researcher would control the conditions under which the subjects would be tested.

Limitations of the Study

This research, which was focused on the relationships among the subjects' (a) learning style strengths, (b) methods of self-instruction, (c) achievement, and (d) attitude toward math class, was limited by the learning style characteristics of the participating sixth grade middle-school math students in one suburban Shelby County school district and the extent to which they resembled other students in suburban schools elsewhere. Therefore, the results of this investigation are applicable only to this sample or populations essentially similar to the population from which this sample was drawn.

Research Design

A repeated measures design was used in this investigation to include pre- and post-testing of achievement and sixth-grade students' attitude toward mathematics. Several independent variables (groups, teacher, and time) were incorporated into this

study. Experimental and control groups were selected based on intact classrooms with similar achievement and attitudes. The teachers participating in this research had more than 15 years in education and were chosen due to their training in the Dunn and Dunn model of learning styles. The experimental treatment lasted a period of 4 weeks. Both quantitative and qualitative strategies were used for analysis (Figure 1).

Definitions of Terms

The following terms are defined as they pertain to this study:

Learning style is described as each person's ability to absorb and retain new and difficult information, values, facts, or concepts. Learning style is directly influenced by at least 18 different elements of five basic stimuli (environmental, emotional, sociological, physiological, and psychological). Included are the elements of design, intake, light, mobility, motivation, perceptual preference, persistence, responsibility, sound, structure, temperature, time, and varied, self, peer, or adult learning (Dunn et al., 1991).

Perceptual preference is the sense or modality through which the individual best remembers when learning new and difficult information. For this investigation, four modalities constituted the learning-style element of perceptual preference. They were operationally defined in terms of the subjects' standard scores on the Learning Style Inventory (LSI) (Dunn et al., 1991).

Attitude toward instructional method is the individual's affective response to the learning experience, as measured on an adaptation of a semantic differential attitudinal questionnaire developed by Pizzo (1981).

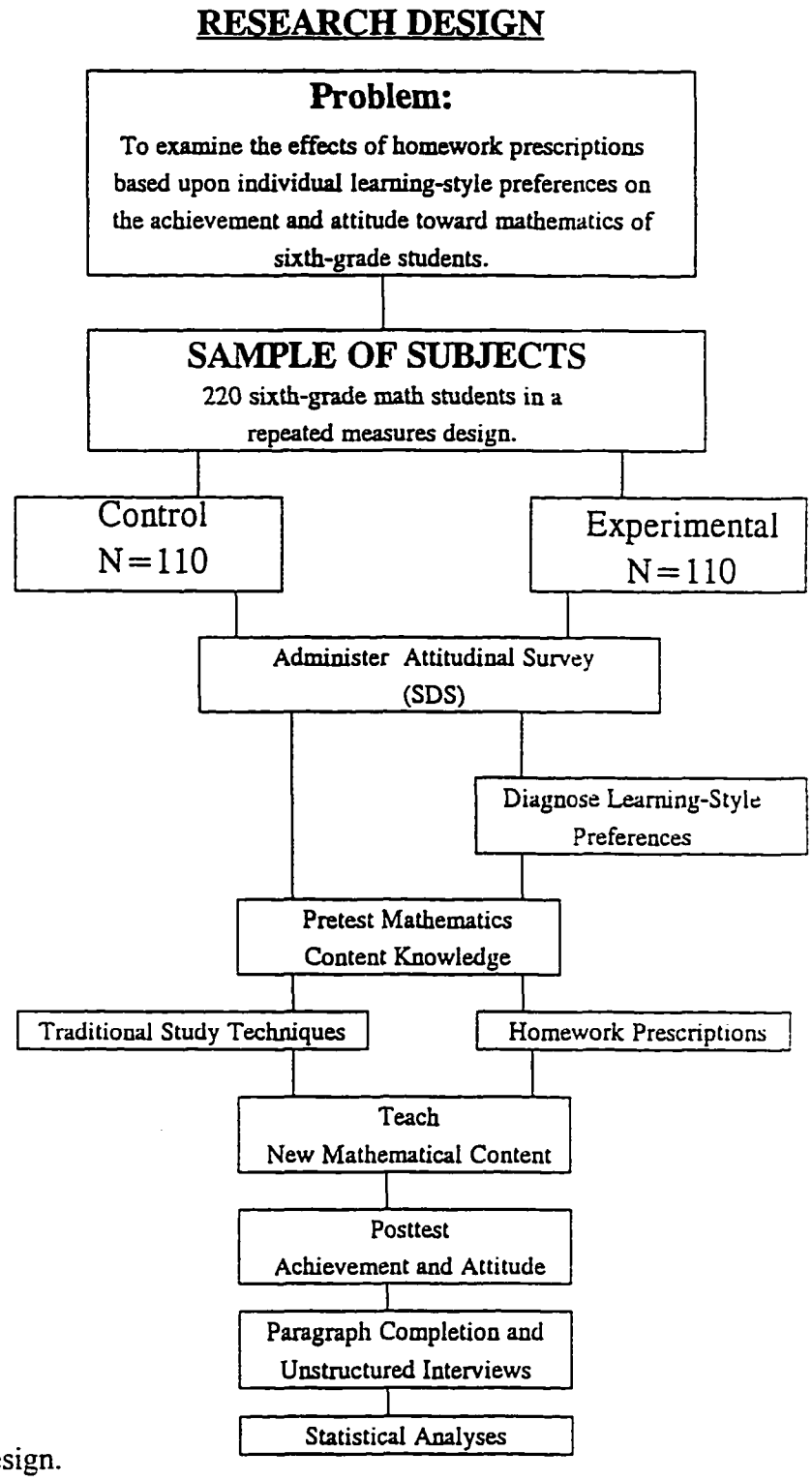

Figure 1. Research design.

Summary

For the United States to be competitive in a global society, students must become math-skilled. Research must be conducted in the area of students' achievement and their attitude toward math. This study focuses on the effects of homework prescriptions based upon individual learning-style preferences on the achievement and attitude toward mathematics of sixth-grade students.

Organization of the Study

Chapter I presents an overview of the problem with the introduction, problem statement, and the significance of the study. Assumptions and terms are defined and limitations of the study are discussed. Chapter II includes a review of the literature as related to the study. Methodology and procedures, a description of the materials and instrumentation, the collection of data, and an explanation the statistical analysis used are given in Chapter III. Chapter IV presents the findings and analyses of the data. Chapter V summarizes the findings, makes conclusions, and discusses the implications for leadership and further research.

CHAPTER II

Review of the Literature

Introduction

This chapter, which focuses on academic achievement as related to various instructional methods, presents a review of the literature relevant to the impact of study skills programs on sixth-grade students' achievement and their attitudes connected with the study of math. This chapter is divided into four major sections and their related components. The first section highlights research on academic achievement and instructional methods; the second discusses individual learning styles; the third describes three comprehensive models, additional research studies, the Dunn and Dunn Learning Styles Model (Dunn & Dunn, 1992) and its impact on academic achievement; and the fourth describes teaching to individual learning-style perceptual strengths, learning style characteristics of adolescents, and the research equipping students to teach themselves and/or to study through their learning style strengths and how it has affected their attitudes.

Academic Achievement and Instructional Methods

The problem of a nationwide decline in mathematics scores is of increasing concern to educators (Advisory Panel of the Scholastic Aptitude Test Score Decline [Advisory Panel], 1977; Carpenter, Corbitt, Kepner, Lindquist, & Reys, 1980).

Achievement patterns across the country verify a sharp decline at the junior high level, despite the fact that elementary grade students continue to perform at or above grade level in mathematics (Maeroff, 1981).

Traditional methods of instruction imply that children learn the same things at the same time. Recent investigations, however, provide evidence that students vary in the ways they absorb and retain information, knowledge, and skills (Dunn, 1982). Yet, the response to the deficiencies in mathematics has been to use new explanations, materials, and drill (Kogelman & Fleishman, 1981). This approach has brought about only minimal improvement in achievement levels, while students' attitudes and self images have worsened as the result of repeated failure (Gibb, 1975; Willoughby, 1970).

Learning Styles

Knowledge of learning styles has long been seen as a powerful tool for teachers, and it is equally valuable to students. By examining their own learning styles, students can determine responsive strategies for accomplishing their academic tasks effectively (Hand, 1990). Keefe (1982) developed the following definition of learning styles: "Learning styles are the characteristic cognitive, affective, and psychological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" (p. 52). In simple terms, learning style is the way in which each student begins to concentrate on, process, internalize, and retain new and difficult academic information or skills (Dunn & Dunn, 1992, 1993; Dunn, Dunn & Perrin, 1994).

To identify students' learning styles, first it is necessary to examine, individually, their multidimensional characteristics to determine which are most likely to trigger their

concentration, to help them maintain it, to enable them to respond to their natural processing style, and thereby to contribute to their long-term memory (Dunn & Dunn, 1993). A comprehensive learning style model is necessary for identifying individual learning styles. Only three comprehensive models have been published, and each has a related instrument designed to reveal individuals' styles based on the variables it includes (DeBello, 1990).

Comprehensive Learning-Styles Models

Dunn and Dunn Model

Among the earliest learning-styles researchers were Kenneth and Rita Dunn (DeBello, 1990). Their multidimensional model contains 21 elements and includes five stimulus groups that encompass environmental, emotional, sociological, physiological, and psychological strands. Elements that affect individuals strongly are referred to as *strong preferences*, others that are important, but influence to a lesser degree, are called *preferences* (Dunn & Dunn, 1978). The Dunns' model is the basis of a diagnostic/ prescriptive approach that is initiated by identifying individuals' styles using a self-report instrument. Critical to the Dunns' approach is the Learning-Style Inventory (LSI) (Dunn et al., 1991). The LSI is the first comprehensive approach to assess an individual's learning style, in which each person concentrates on, learns, and remembers new and difficult academic information. The instrument assists in prescribing the type of environment, instructional resources, social groupings, and motivational factors that maximize personal achievement.

Extensive research using the LSI has made it the most widely used assessment instrument (Keefe, 1982). Because of its reliability and validity, it has been used in

research on learning styles by more than 90 institutions of higher education (Dunn & Dunn, 1993). Two separate reports agreed on its reliability and validity in comparison with those of other instruments (Curry, 1987; DeBello, 1990). The Ohio State University's National Center for Research in Vocational Education published the results of its 2-year study of instruments and reported that the LSI had "impressive reliability and face and construct validity" (Kirby, 1979, p. 72).

National Association of Secondary School Principals (NASSP) Model

The second comprehensive model is the National Association of Secondary Principals (NASSP) Learning-Style profile. This model encompasses physiological/ environmental, cognitive, and affective domains as well as an information-processing perspective. The Learning Style Profile (LSP) is a 42-page, 126-item assessment intended for use with secondary students (DeBello, 1990). In terms of the elements of the NASSP model, there is a great deal of similarity to the Dunn and Dunn model. Study skills are addressed similarly to the prescriptive process of the Dunn and Dunn model, which stresses that students learn through their strongest preference, need to be reinforced through their secondary strength, and then should be taught to apply the new information creatively.

The NASSP model, although similar in many ways to the Dunn and Dunn model, is an amalgamation of several approaches. Cognitive skills items were derived from Witkin's Group-Embedded Figures Test (GEFT) (Kepner & Neimark, 1967; Witkin, Oltman, Raskin, & Karp, 1971); perceptual responses were adapted from Reinhert's (1982) Edmond's Learning-Style Identification Exercise (ELSIE); and environmental, affective, and physiological items emanated from the Dunn and Dunn model. Keefe

(1979) reported that, whereas significant correlations were established among the LSP, LSI, and ELSIE, no significant correlation emerged between the LSP and the GEFT. Curry (1987) reported similar findings. Furthermore, Curry purported that the sections of the LSP and Reinert's ELSIE have neither reliability nor validity and that the strongest aspects of the NAASP model were derived from these variables adopted from the Dunn and Dunn model.

Hill Model

The third comprehensive model is the Hill Model, an essentially cognitive-style profile. Hill, one of the earliest theorists in the field, can be considered the father of learning styles. His cognitive style mapping is an elaborate process of obtaining a cognitive-style profile. It involves a self-report test, which takes approximately 50 minutes to administer, and an interview component. Hill defined learning style as the unique way in which an individual searches for meaning. To Hill, that process was reflected in (a) the processing of theoretical and qualitative symbols, (b) modalities of inference, and (c) cultural determinants (DeBello, 1985).

Although Hill's Cognitive Style Interest Inventory has been revised since his death, it remains rather complex. Curry (1987) reported that this instrument showed no reliability or validity, but that it should be recognized for its early contribution to the body of research on learning style through a comprehensive diagnostic/prescriptive approach.

Research Studies on Additional Models

Kolb Model

Dunn and Dunn, NASSP, and Hill represent the comprehensive models. Numerous research studies have used the Kolb LSI (1976), a model designed and tested only on adults, that involves a four-stage cycle. The core of the model is a simple description of the learning cycle of how adult experience is translated into concepts which, in turn, guide in the choice of new experiences (DeBello, 1990). Kolb's Learning-Style Inventory is a nine-item assessment with four sub-items to be rank-ordered by adults. His model and instrument were designed for, and have been applied to, adult organizational systems and management training. In terms of strength of the instrument, Curry (1987) reported strong reliability, but only fair validity.

Myers-Briggs Model

The related literature also contained studies conducted using the Myers-Briggs Type Indicator (MBTI) to assess learning style. This instrument diagnoses learners' preferences for perceiving meaning, expressing values and commitment, and interacting with the world. Keefe and Ferrell (1990) reported that

> Although learning style develops in ways consistent with individual personality traits, instruments based on personality theory seem to assess style only indirectly. Indeed, the Myers-Briggs scales do not represent distinct constructs in analysis with more robust learning-style elements. (p. 57)

Curry's "Onion" Model

Given the existence of so many varied learning-style instruments, each based on a unique theory, Keefe (1979) classified each in terms of whether it measured either one or a combination of cognitive, affective, or physiological behaviors. Four years later, Curry

(1983) developed the "onion" (p. 7) organizational model as a framework for categorizing diverse learning-style theories. In her subsequent psychometric analysis, Curry (1987) examined each concept, categorized it, and reported the reliability and validity evidence for each of the related instruments. The Curry onion model was constructed in three layers, or levels:

Level 1. Instructional Preference: the individual's preferred instructional environment and approaches (learner, teacher, content) for learning. Examples in this category include the Learning-Style Inventory (Dunn et al.. 1991) and the Cognitive-Style Interest Inventory (Hill, 1976).

Level II. Information Processing: the individual's preferred intellectual approach to assimilating information. Examples in this category include the Learning-Style Inventory (Kolb, 1976) and the Paragraph-Completion Method (Hunt, 1979).

Level III. Cognitive Personality Style: the individual's underlying personality dimensions (outside the instructional environment) that define the preferred approach to adapting and assimilating information. Examples in this category would include the Myers-Briggs Type Indicator (Myers & McCauley, 1962) and the Embedded-Figures Test (Witkin et al., 1971).

The practicality of Curry's onion model was subsequently tested by Marshal (1987), who conducted a study designed to examine the validity of the learning-style topology conceptualized by Curry (1983) 4 years earlier. Marshal hypothesized that the Kolb (1976) model, included within Curry's information processing format (Level II). would be discernable and independent of students' identifiable instructional behaviors (Level I). Marshal's conclusions suggested the existence of discrete conceptual levels

that measure differing learning-style constructs. He purported that an information-processing instrument (Level II) would not provide diagnostic information concerning instructional preference (level I). Both Curry (1983) and Marshall (1987) strongly recommended that investigators carefully consider the most appropriate level-learning/cognitive style when choosing a specific construct. If the research goal is to measure an individual's instructional method preference, the investigator must make a critical choice concerning which learning-style instrument to employ. One of the recurring problems with the research on adult learning styles has been the use of instruments that measure a Level II or III construct for predicting behavior governed by a Level I design (Marshal, 1987). If properly applied, the method provided by Curry (1983, 1987) and Marshall (1987) may eliminate confusion and significantly increase the effects of future learning-styles research.

The Dunn and Dunn Learning Style Model

Research on the Dunn and Dunn model of learning styles is more extensive than the research on most previous learning-style models. As of 1993, that research had been conducted at more than 100 institutions of higher education, at grade levels from kindergarten through college, and with students at most levels of academic proficiency, including gifted, average, underachieving, at-risk, dropout, special education, vocational, and industrial arts populations (Dunn & Dunn, 1993). That body of research, when combined with other learning-styles research, verifies the existence of individual differences among students and, therefore, provides closer directions for either teaching individuals through their style patterns or teaching them to teach themselves by

capitalizing on their personal strengths. This verification is the focus of this investigation.

Learning styles vary with (a) age (Price, 1980), (b) achievement level (Milgram, Dunn, & Price, 1993), (c) culture (Dunn & Griggs, 1990; Dunn, Griggs, & Price, 1993; Milgram et al., 1993), and (d) global versus analytic processing (Dunn et al., 1990; Dunn, Cavanaugh, Eberle, & Zenhausern, 1982). Dunn and Dunn (1992, 1993) described learning style in terms of individual reactions to:

1. four elements in each person's immediate instructional environment (sound, light, temperature, design);

2. four additional elements comprising each person's emotionality (motivation, persistence, responsibility, structure);

3. six sociological preferences (learning alone, in a pair, with peers, as part of a team, with either a collegial or authoritative adult, and/or in a variety of ways as opposed to patterns or routines); physiological characteristics (auditory, visual, tactual, and/or kinesthetic perceptual preferences, time-of-day energy levels, intake, and mobility needs); and

4. global versus analytic processing determined through correlations among sound, light, design, persistence, sociological preference, and intake (Dunn et al., 1982; Dunn et al., 1990) (see Figure 2).

Instruments for Identifying Students' Learning Styles

Teachers cannot correctly identify all the characteristics of learning style (Dunn et al., 1989). Some aspects of style are not observable even to an experienced educator. Two instruments used to identify characteristics that are observable are the Learning

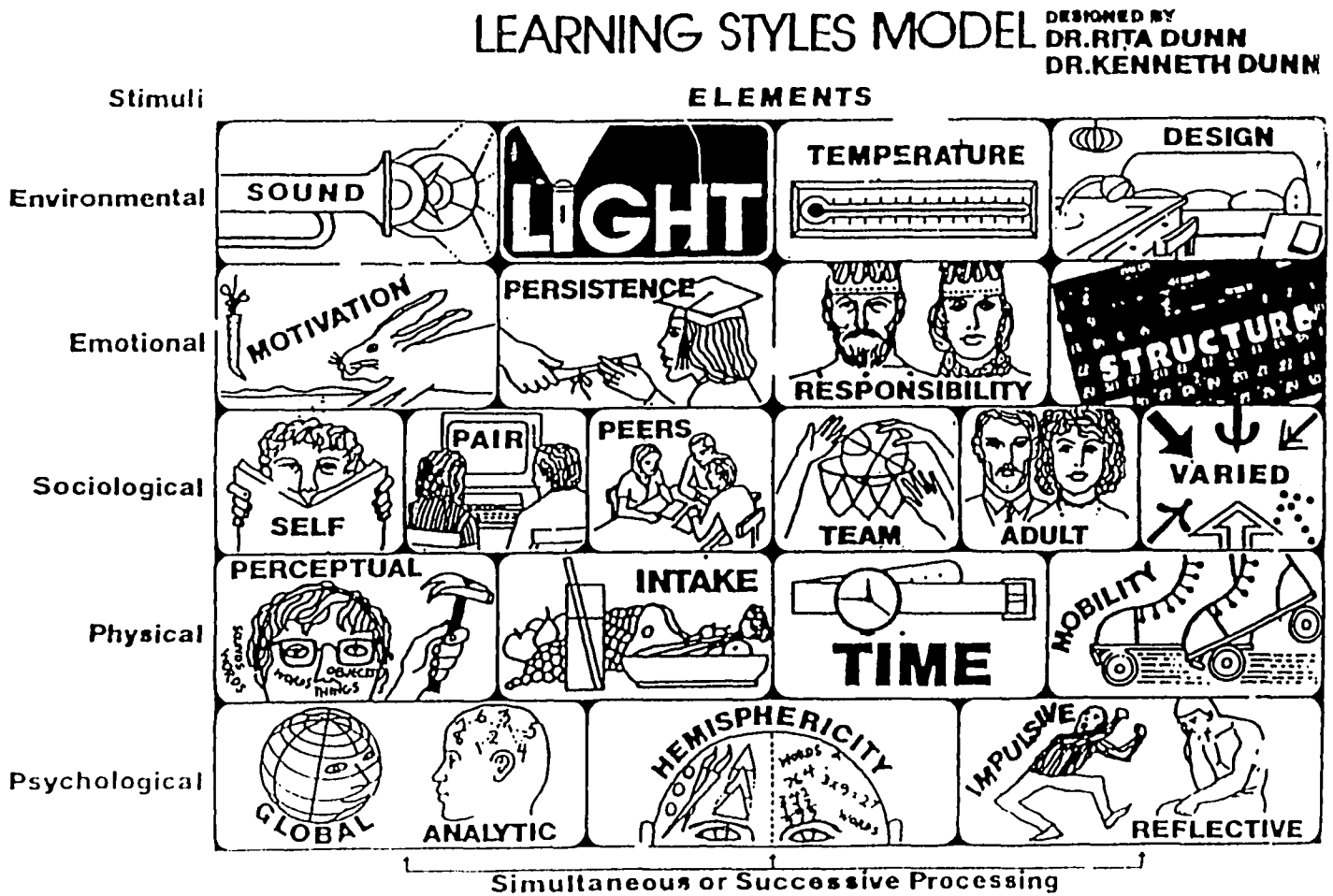

Figure 2. Learning styles model. (Source: Dunn & Dunn, 1978. Used by permission.)

Style Inventory (LSI) (Dunn et al., 1991) and Productivity Environmental Preference Survey (PEPS) (Dunn et al., 1982). Both identify learning-style preferences, but the former is appropriate in different versions for students in grades 3-12, whereas the latter is appropriate for adults.

Learning Style Inventory (LSI)

The LSI consists of 100 statements that elicit self-diagnostic responses on a 5-point Likert scale in approximately 25 minutes. The data collected from this assessment yields a computerized profile of each individual's preferred learning style, based upon the Dunn and Dunn Model, whose reliability and validity has been established impressively.

Since then, the LSI evidenced predictive validity (Dunn et al., 1990; Dunn et al., 1986; Dunn et al., 1985; Pizzo, Dunn, & Dunn, 1990). In a comparative analysis of the conceptualizations of learning style and the psychometric standards of nine different instruments that purportedly measure learning styles, only the LSI was rated as having good or better reliability and validity (Curry, 1987). A meta-analysis of all the experimental studies conducted with the LSI (Dunn et al., 1991) and the PEPS (Dunn et al., 1982) during the 1980-1990 decade identified 42 experimental studies used to determine the value of teaching students through their learning-style preferences (Dunn et al., 1995). The LSI is easy to administer and interpret and has been employed in research at more than 100 institutions of higher education (Center for the Study of Learning and Teaching Styles, 1995).

Productivity Environmental Preference Survey (PEPS)

The PEPS, which measures the learning-style preferences of adults, also consists of 100 dichotomous questions that elicit self-diagnostic responses to 18 discrete learning-

style elements on a 5-point Likert scale. Construct validity for the perceptual subtests of the PEPS was established by Buell and Buell (1987), Ingham (1991), and LaMothe et al. (1991).

The LSI identifies key elements of the student's learning style, and the resultant information is shared then with the student. The ideal would be to have teachers teach to the students' individual styles, but, because precedence for individualized instruction has not been established at all levels, students are taught how to teach themselves based on their own style strengths. This study investigated the impact of the 22 different elements considered in the LSI on students' learning, with special attention focused on the perceptual preferences: auditory, visual, tactile, and kinesthetic.

Teaching to Perceptual Strengths

In addition to the instructional environment, sensory preferences influence the ways in which students master new and difficult information. One such element of learning style is perceptual strength. Research has demonstrated significant gains in test and attitude scores whenever students are taught through their perceptual strengths rather than their weaknesses (DeBello, 1985; Dunn, 1987; Dunn et al., 1986; Dunn, Dunn, Primavera, Sinatra, & Virostko, 1987; Dunn et al., 1985; Dunn, Pizzo, Sinatra, & Barretto, 1983; Hand, 1990; Hodges, 1985; Ingham, 1990; Lynch, 1981; MacMurren, 1985; Miles, 1987; Murrain, 1983; Perrin, 1984; Pizzo et al., 1990; Shea, 1983; Spires, 1983; Trautman, 1979; White, Dunn, & Zenhausern, 1982). Perceptual preferences affect more than 70% of school-age youngsters. Secondary teachers have reported increased achievement and interest when students were taught initially through their most-preferred modality (Dunn & Griggs, 1988).

The literature has documented that students who are introduced to new material through their perceptual preferences remembered significantly more than when they were introduced to new material through their least preferred modality. That was evidenced among primary (Carbo, 1980; Urbschat, 1977; Wheeler, 1980, 1983), elementary (Hill, 1987; Weinberg, 1983), secondary (Bauer, 1991; Kroon, 1985; Marino, 1993; Martini, 1986; McFarland, 1990; Moore, 1992), college, and adult learners (Ingham, 1990; Nelson, 1991).

Most teachers teach by talking, questioning, and discussing. That practice presupposes that most listeners are capable of remembering at least three-fourths of what they hear. When they can do this, students are called *auditory learners.* Approximately 30% of the population is auditory and can remember at least 75% of what is heard in a 40-50 minute lecture (Dunn et al., 1986). Of the school age population, 40% are visual and can remember approximately 75% of what is either read or seen; 15% require tactual interaction, a hands-on approach, with what is being learned. However, that reference is to learners in kindergarten through adulthood, and the younger the child, the more tactual the exposure to new and difficult information needs to be (Carbo, 1980; Crino, 1984; Kroon, 1985; Martini, 1986; Urbschat, 1977; Weinberg, 1983). Kinesthetic learners require movement while learning; they learn best through activities, such as role playing, simulations, interviewing, on-the-job interactions, and an educational adaptation called body games (Dunn & Dunn, 1978) or floor games (Dunn & Dunn, 1993). The perceptual senses appear to develop gradually with maturation, beginning with the tactual/ kinesthetic combination and evolving into visual and then auditory (Keefe, 1979).

Whereas research on learning styles has provided numerous examples of improved attitude and increased academic achievement on elementary, secondary, and college students, no research has been conducted to determine whether learning styles prescriptions impact middle school youngsters.

Teaching Middle School Youngsters

Information processing has been described interchangeably in the literature using such terms as *analytic/global, left/right, sequential/simultaneous,* and *inductive/deductive*. These variables tend to parallel each other except for the inductive/deductive processing, which identifies a visual ability to discern the whole from its parts (Dunn & Griggs, 1995).

Analytic learners process information sequentially toward a conceptual understanding. Globals learn from the whole to its parts and learn when information is introduced in the form of stories, applications, and graphics, interchangeably. Each strategy "is a reflection of a trend toward optimalization of efficient use of neural space" (Levy, 1982, p. 224) but permits reasoning through different strategies (Geisert & Dunn, 1991; Levy, 1979; Zenhausern, 1980).

Whether middle school students are analytical or global, left or right, sequential or simultaneous, or inductive or deductive processors, they master identical information or skills when taught with instructional methods or resources that complement their learning styles. That conclusion was documented in mathematics at the elementary level (Jarsonbeck, 1984), high school level (Brennan, 1984), and community college level (Dunn et al., 1990).

Many middle school analytics prefer to learn in quiet, well-illuminated, formal settings. They often have strong emotional needs to complete tasks and rarely eat, drink, chew, or bite on objects while learning. Global students appear to concentrate better with distractors (music or background sounds), soft lighting, an informal design, and some form of intake (Dunn & Griggs, 1995). In addition, globals prefer to work on several tasks simultaneously (Dunn & Griggs, 1995). Neither study procedure is better nor worse than the other; they are merely different processing styles. With an IQ of 145 or higher, most gifted students are global (Cody, 1983; Perrin, 1990; Sinatra, 1990), as are most underachievers. Differences between the high IQ and underachieving globals can be attributed to the motivation and perceptual preferences.

As is true with all students, middle school underachievers have a lower level of motivation than do achievers. The biological development of the underachievers' perceptual strengths that is accompanied by the decreasing motivation of the global student becomes more evident the longer they remain in conventional classrooms. There is no current knowledge of ways to intervene in their biological development, but success has been attained through instructional techniques addressing perceptual preferences (Carbo, 1980; Gardiner, 1986; Ingham, 1991; Jarsonbeck, 1984, Kroon, 1985; Martini, 1986; Neely & Alm, 1993; Urbschat, 1977, Weinberg, 1983; Wheeler, 1983).

Both analytical and global instruction should be used within the classroom. Global students require environmental differences from those often observed in traditional classes. They need more encouragement than do analytical students, and require short, varied tasks because of their lower motivation and persistence levels. Both analytic and global students learn more easily when lessons are interesting than when

they are not, but globals require that difficult information be both interesting and relevant to their lives (Dunn & Griggs, 1995).

Homework Prescriptions Matched to Students' Learning Styles

Regardless of the style of individual students, doing homework by studying in ways that complement personal learning styles make it more enjoyable and productive. Individual homework prescriptions provide specific strategies and techniques to enhance study by capitalizing on individual strengths (Dunn & Klavas, 1992). One resource that has been made available to teachers, parents, and students to assist with homework is the Homework Disk.

The Homework Disk is a software package that analyzes the individual's preferred learning style based on the computerized LSI profile (Dunn, Klavas, & Ingham, 1990). That analysis is then converted by a computer program into a series of questions for studying and doing homework based on individuals' strong preferences (scores of between 20-29 or 70-80 on the LSI) and preferences (scores of between 30-40 or 60-69 on the LSI). Each person's set of directions is called his or her *Homework Prescription.* Nelson et al. (1993) reported increased achievement for community college students, and Lenehan et al. (1995) reported increased achievement in science courses among undergraduate nursing students who had studied with these prescriptions based on their learning styles.

Summary

Knowledge of learning styles is invaluable as students respond to difficult information in various ways that trigger concentration for long-term memory. Although there are many learning-style models, the one with the most extensive research base is the

Dunn and Dunn model. Both the Learning Style Inventory (Dunn et al., 1991) and the Productivity Environmental Preference Survey (Dunn et al., 1982) are used to identify learning-style preferences and have been rated as having good or better reliability and validity (Curry, 1987). Using these instruments for diagnosis provides the means for formulating adequate prescriptions to increase math achievement and improve students' attitudes.

CHAPTER III

Research Methodology

Description of Subjects

Research was conducted to examine the effects of homework prescriptions based upon individual learning-style preferences on sixth graders' achievement and attitude toward mathematics. This study used a repeated measures design of sixth-grade math students within a public, suburban middle school in north Shelby County outside of Birmingham, Alabama.

Selection of Sample

The total enrollment for the 1995-96 school year consisted of 937 students (466 females and 471 males) from a middle school in North Shelby County. Shelby County has been described as the fastest growing county in the state and is one of the top 10 growth areas in the nation. Its location is a prime factor in the make up of both the community and the school population. The majority of the students come from white-collar professional families. For purposes of this research, 220 sixth-grade math students were purposefully selected to participate in a repeated measures design. Subjects were similar in socioeconomic background, achievement, and gender. Both control and experimental groups were comprised of gifted and learning disabled (LD) students with varied learning styles and perceptual strengths. The largest number of LD students (26%) were found to be in the experimental group of Teacher 2 due to the special education

inclusion program within the school. Four classes (110 students) were assigned to the control group and four classes (110 students) to the experimental group. Of the eight classes that made up the control and experimental groups, two control and two experimental classes were assigned to two different teachers. Each of the two teachers were veteran teachers with over 15 years teaching experience, who had received training in learning style techniques. Both practitioners isolated the variable of the physical environment by providing a classroom design that included both formal and informal arrangements. All classes contained students from feeder schools as well as transfer students from outside the district. This distribution was consistent with the annual entry of students into the sixth grade middle school setting (see Table 1). The subjects included 109 males and 111 females, the majority were Caucasian (210). Other ethnic backgrounds included 2 Asians, 7 Blacks, and 1 Hispanic. The students ranged in age from 10 to 12 years (see Table 1).

Context to Literature

The context within which this study was conducted is described as a progressive middle school setting that uses innovative techniques to provide educational excellence for its students. The school constructed in 1993 follows a middle school concept, with departmentalization and teaming in grades six through eight. Such current educational practices as a rotating schedule (to accommodate student/teacher time preferences and energy levels) and the inclusion model for learning disabled students has been incorporated. The instructional staff was chosen for this school based on their diversified strengths in meeting student needs.

Table 1

Population Description

Description	Control*		Experimental*	
	No.	%	No.	%
Student entry				
Feeder schools	98	89	103	94
Transfer students	12	11	7	6
Gender				
Male	46	42	63	57
Female	64	58	47	43
Ethnicity				
Asian	1	1	1	1
African American	2	2	5	5
Caucasian	107	97	103	93
Hispanic	0	0	1	1
Achievement level				
Gifted	27	25	33	30
Average	80	73	64	58
LD/at-risk (inclusion)	3	2	13	12

*$N = 110$.

The selection of the two sixth-grade teachers for this study was based on their desire to make a contribution to research that could result in improving the educational program and their understanding of the Dunn and Dunn Model of learning styles. Each teacher's processing and teaching styles were different. Although they had diversified styles, both classroom designs included formal and informal areas for learning. These areas included bright lighting, desks, and quiet in the formal areas to accommodate the

needs of analytic learners and subdued (dim) lighting, sofas and easy chairs, intake, and music (as a distractor) for global learners.

The analytic/sequential processing style of Teacher 1 was modified to incorporate instructional strategies that addressed both the analytic and global learning styles of her students. The global/simultaneous processing style of Teacher 2 made it difficult to modify her instructional style, as she used strategies that primarily addressed global students. Intact classrooms used in this research were assigned to include experimental and control groups with both teachers. Students with Teachers 1 and 2 included a combination of both analytic and global students, but students assigned to the classes of Teacher 2 were largely global due to the inclusion model in place.

Materials and Instrumentation

The materials employed in this study included two instruments: the Learning-Style Inventory (LSI) (Dunn et al., 1990) (Appendix A) and a Semantic Differential Scale (SDS) (Pizzo, 1981) (Appendix B). Students were provided with their particular learning-style profile generated from the LSI (Appendix C). Students in the experimental classes also were provided with individual computer-generated prescriptions that recommended specific strategies for accommodating their learning-style preferences (Appendix D).

Learning-Style Inventory (LSI)

This instrument provided a comprehensive approach for identifying each student's preferred style to function, learn, concentrate, and perform during educational activities. The LSI yielded measures in four areas: (a) immediate environment (sound, light, temperature, and design); (b) emotionality (motivation, persistence, responsibility and the

need for either structure or flexibility); (c) sociological preference (self-oriented, peer oriented, authority-oriented and several or varied ways; and (d) physiological need (perceptual preferences, time of day, intake, and mobility) (Dunn et al., 1991).

The LSI is a 104-item, self-report questionnaire developed through content and factor analysis (Dunn et al., 1991). The questionnaire generated responses on a 5-point Likert scale and can be completed in approximately 30 to 40 min. It also yielded a consistency score that indicated the accuracy with which each respondent had answered the questions. Questions concerning each of the areas were presented and subjects' responses tended to reveal personalized characteristics that, when combined, represented the way in which the individual preferred to study or concentrate (Dunn & Dunn, 1978). The data collected from the LSI yielded a computerized profile of each student's preferred learning style. A standard score was generated for each of the elements. Standard scores of ≥ 60 and ≤ 40 revealed either positive or negative preferences for each element.

Instrument Validity

Ohio State University's National Center for Research in Vocational Education published the results of its 2-year study of instruments that identify learning style and reported that "the LSI has established impressive reliability and face and construct validity" (Kirby, 1979, p. 72). Since examination by the Center for Learning-Styles (1989/1990) at St. John's University, the LSI has evidenced predictive validity (Ingham, 1991; Nelson et al., 1993). Evidence of construct validity was established using factor analyses procedures. All factors had eigenvalues of >1.00 with values ranging from 1.01 to 6.81 (Dunn et al., 1991).

A meta-analytic validation of the learning-style instrument has been conducted through experimental studies over the past 10 years in 13 different universities. A comparative analysis of the conceptualization of learning style and the psychometric standards of nine different instruments measuring learning-style preferences have proved the Dunn and Dunn model to be valid (Curry, 1987; DeBello, 1990; Kirby, 1979) because it measures conditions or characteristics that can be used to enhance academic performance.

Predictive validity has been indicated by learning-style interventions in over 36 experimental and quasi-experimental studies, in which accommodations that matched students' preferences have invariably resulted in improving their academic achievement and attitudes toward learning.

Instrument Reliability

The LSI manual (Price, Dunn, & Dunn, 1991) published the substantial reliability data. For each LSI area for males and females, the mean, standard deviation, reliability and standard error were calculated. The Hoyt (1941) analysis of variance procedure was used to estimate reliability for each subscale. The LSI was deemed equivalent to the Kuder and Richardson (1937) formula (20) procedure.

Research reported in 1988 indicated that 95% (21 of 22) of the reliabilities were ≥.60 for the Likert scale English translation. The areas with the highest reliabilities included: noise level (.77), light (.59), temperature (.76), design (.61), motivation (.59), persistence (.61), responsibility (.79), structure (.70), learning alone/peer oriented learner (.85), presence of authority figures (.71) , learning in several ways (.69), auditory (.74), visual (.74), tactile (.60), kinesthetic preferences (.64), requires intake (.86), evening/

morning (.67), afternoon (.50), needs mobility (.91), parent figure motivated (.42), and teacher motivated (.44).

Semantic Differential Scale (SDS)

For the purpose of this study, attitudes toward instructional approaches were assessed through the Semantic Differential Scale developed by Pizzo (1981) and later employed by De Bello (1985), Giannitti (1988), Hodges (1985), and Napolitano (1986). Pizzo initially developed the scale to "compare the attitudes of students tested in an acoustic environment congruent with their preferences for the element of sound with those of students tested in an acoustic environment incongruent with their preferences for sound" (p. 155).

Implying that attitudes have both direction and intensity and a basis for quantitative indexing, Osgood, Suci, and Tanenbaum (1957) suggested that attitudes could be ascribed to some basic bipolar continuum—semantic space—with a neutral reference point. Arbitrary ratings were assigned to scales representing specific concepts. Twelve bipolar items were included on a 5-point Likert scale, in which the highest score, 60, indicated a positive attitude toward math. The authors contended that "such a conceptual structure is a kind of map, a bit of 'semantic geography' if you will, which provides an objective picture of subjective meaning within the subject" (p. 96).

The authors isolated three dominant factors: (a) evaluative (good-bad), (b) activity (fast-slow), and (c) potency (strong-weak). However, they emphasized that those factors do not exhaust the semantic space, and, therefore, one does not need to stay only with those three scales. Two other scales offered by Osgood and his associates included stability (calm—anxious) and receptivity (colorful—dull). Pizzo (1981) added the factor

of stability to the SDS. Therefore, the resulting semantic differential developed by Pizzo (1981) included 12 bipolar adjective pairs—3 word pairs for each of 4 factors.

Previous research includes such studies as that of Hodges (1985), in which Pizzo's adaptation of the SDS instrument was employed in a study that included an assessment of student attitudes toward learning mathematics in a formal and informal setting. De Bello (1985) used the Pizzo (1981) SDS in a study that included assessing student attitudes toward writing revision tasks when they matched and mismatched their sociological preference, either for learning alone, with peers, or with an adult. Later, Giannitti (1988) used the Pizzo (1981) instrument in her investigation to assess middle school students' reactions to instructional methods complementary to and dissonant from their diagnosed sociological preferences.

Validity

The SDS recorded subjects' reactions to 12 word pairs to assess their attitudes about instructional methods. Twelve word pairs used in this investigation included: (a) evaluation (confused—clear-minded, bad—good, successful— unsuccessful); (b) potency (strong—weak, confident—uncertain, dull—sharp); (c) activity (energetic—tired, shaky—steady, tense—relaxed); and (d) stability (nervous—calm, peaceful—frustrated, wonderful—terrible).

There is little question about face validity of the differential, because it clearly differentiates among and clusters concepts. Experimental studies in attitude change indicate that pre- and post- exposure attitudes showed significant shifts toward the proposition when compared with the control group. When data were analyzed in terms of predictive validity, approximately 70% of the changes were in the predicted direction.

The Pearson product-moment correlations between predicted and obtained results were .63 on the source, and .71 for the concept—both highly significant ($p < .01$ in each case).

Reliability

The Cronbach's alpha was employed to assess the reliability coefficient of the SDS. The alpha coefficient was .94 for the Session 1 administration, and .93 for the Session 2 administration.

Collection of Data

Procedures

A repeated measures design was used to compare sixth-grade math students. Four classes were assigned to the control group and four to the experimental group. Students were taught in the traditional manner with no additional treatment for the first 9 weeks of the first semester.

During the 3rd week of the study, the experimental group completed the LSI to determine their learning-style preferences. The students' answer forms were subjected to computer processing in which each individual's profile was analyzed to determine preferences for each of the elements contained in the inventory.

Both the control and treatment group completed the SDS at two different intervals during the course of the study. This instrument measured their attitudes while taking math before their individual learning-style study techniques were addressed and any variations in their attitudes after application of the homework prescription. The first administration of the SDS (pretest) was given during the first week of school to determine attitudes early in the year prior to the treatment.

For purposes of conducting a comparative analysis of the academic achievement of the control and experimental groups, a criterion-referenced test was administered and scores recorded during the 9th week (pretest) of school prior to initiating the learning-style treatment.

To ascertain whether the students in the experimental group followed the instructions provided on their homework prescriptions, a verification form (Appendix E) was filled out jointly by students and parents on a daily basis throughout the study.

At the end of the study, all students were posttested using a criterion-referenced math test and SDS attitudinal scale to determine whether the learning-styles prescription significantly influenced academic achievement and attitude in math.

Learning-Style Treatment

The treatment consisted of two training sessions, with weekly follow-up sessions throughout implementation of the homework prescription, and a culminating data collection session. The first training session for students in the experimental group occurred during the 9th week of the first semester to distribute their personalized learning style profiles and their corresponding individual prescriptions for studying. The second training session was a meeting with parents of students in the experimental group to provide them with further explanation of the implementation of the learning-style prescription during the 10th week. Other meetings were scheduled as deemed necessary to clarify homework prescriptions.

Session 1

Students in the experimental group and their parents received consent forms (see Appendix F) that described the study to be conducted: the use of the learning style profile

and individualized homework prescriptions were explained and consent to participate was obtained from students and their parents. All students in the experimental group met for discussion and explanation of all elements of the profile significant to the individual (standard scores of ≤40 and ≥60). Those students who were unable to attend the first-opportunity meeting were permitted an optional meeting.

The LSI assessed individual preferences in the following areas: (a) immediate environment, (b) emotionality, (c) sociological factors, and (d) physiological factors. The elements within each area were the basis for all students' discussions with this investigator.

Immediate environmental. These were the elements of sound, light, temperature, and seating design. The student's preferred type of environment for studying new and difficult material was determined and improvements were made to the study environment to complement each student's need for quiet or sound, bright or soft lighting, a warm or coo l setting, and a formal or informal seating pattern.

Emotional. Included in this area were the elements of motivation, persistence, responsibility, and structure. Options and alternatives were provided for students according to their need for motivation to complete assignments. Students needing structure were instructed to be certain to ask for additional directions or information when needed.

Sociological. These elements described with whom each student is likely to achieve most efficiently, for example, alone, in a pair, with two or more classmates with a teacher, or in any combination of the above.

Physiological. Included in this preference were stimuli, such as the elements of intake, time, mobility, and perceptual preference. Students were informed of their best time of day to be involved in learning new and difficult material and whether it was advisable for them to take a break for a snack or to move about instead of working for long unbroken periods. In reference to perceptual preferences, the students were given specific strategies. For example, students who had an auditory strength found it easy to learn by listening and, therefore, could remember at least 75% of what was said during a lecture. If, on the other hand, a student's profile showed a low auditory score, indicating that the student had difficulty remembering at least 75% of what was heard during a 40-50 minute lecture, it was recommended that they tape record the lectures and then take good notes from the tape. Visual-strength students were told to read the material before they heard the lecture. The reason for this advice was that, because their strongest modality was visual, the material should be read first and then reinforced through the teacher's lecture. Taping a lecture was also suggested. Kinesthetic students like being active and involved. Sometimes walking while studying helps the kinesthetic student. If, for example, a student had two strengths (auditory and kinesthetic), these students were encouraged to walk and read their study cards out loud.

Session 2

The parents received a notice to meet with the researcher (see Appendix G) for an explanation of students' individual learning-style profiles and homework prescriptions for study. Parents received a homework verification form to ascertain the consistency in which students were following their individual prescriptions. To control the variables of an individual meeting, the researcher met with students in the control group once and

discussed the customary approaches to enhancing learning: tutoring programs, computer lab, think tank, and good study habits. This was accomplished through group meetings in a classroom setting.

Session 3

Students met for data collection, which included the final administration of the SDS, and for a paragraph completion survey (Appendix H) to determine changes in attitude toward the learning-style intervention. Teacher interviews were conducted to produce rich data filled with words to reveal the respondents' perspectives toward the use of the individual learning-style homework prescription.

Data Analysis

The repeated measures design for this research was a pretest-treatment-posttest design, with subjects purposefully assigned to the control group or experimental group. The comparison was made to determine whether there were beneficial effects of using homework prescriptions to providing complete academic assignments in contrast to conventional study skills advice.

All students were given the SDS to measure their attitudes toward studying mathematics prior to and following the treatment. Measurement of the attitudes toward the use of individualized homework prescriptions were examined through an analysis of variance (ANOVA).

First, a comparison was made between the experimental and control groups on their pre-test performances to determine whether the four groups differed at the outset of the study. The criterion-referenced test measuring mathematics achievement was subjected to a repeated measures ANOVA that tested their performances on the post-test

to address the null hypothesis for the study: There will be no statistically significant difference ($p < .05$) in math grades between the sixth-grade students who have received and followed their personal learning-styles prescription and students who have not received a learning-styles prescription.

In addition to the quantitative techniques (Slavin, 1992) of pre- and posttesting, such qualitative strategies (Bogdan & Biklen, 1992) as open-ended interviewing (Maccoby & Maccoby, 1954) was conducted with students and teachers. This qualitative approach allowed the subjects to answer from their own frames of reference and gave them the freedom to express their thoughts about the use of their individualized homework prescription.

Summary

The subjects for this investigation, drawn from math classes of sixth grade students who attended a north Shelby County middle school, were administered two instruments, the Learning Style Inventory (LSI) (Dunn et al., 1984) and the Semantic Differential Scale (SDS) (Pizzo, 1981) to diagnose their preferred learning styles. Both instruments were proved to be valid and reliable. The information gained from these instruments was used to design customized prescriptions for math homework to fit the individual learning-style preferences of the students in the treatment group. A matched set of students served as the control group. Following the treatment period, students' attitudes were compared toward two different homework techniques.

Treatment involved training sessions on individual learning style profiles and corresponding individual prescriptions for the students in the experimental group and their parents. The control group also completed the study survey instruments before and

after the treatment period, but they received no training sessions and were only given standard advice about good study techniques. Each subject received parental permission to participate in this study. Approval to carry out this study was obtained from the Institutional Review Board for Human Use of the University of Alabama at Birmingham (Appendix I).

CHAPTER IV

Findings

Introduction

The effects of individualized learning style prescriptions on sixth-grade math students' achievement and attitude were examined during this investigation. Pre-post comparisons were made between the mean scores of a criterion-referenced math test and an attitudinal survey during a unit on algebraic equations. The independent variable was use or non-use of homework prescriptions based on individual learning-style preferences. A second independent variable was the teacher. The hypotheses were stated in the null form; alpha = .05 was used as the criterion of statistical significance.

Results for Hypothesis I: There will be no statistically significant difference (p <.05) in math grades between the sixth-grade students who have received and followed their personal learning-styles prescription and students who have not received a learning-styles prescription.

Differences in the math achievement between students who used an individualized learning-style prescription and those who used traditional study skills were examined using a repeated measures design. An analysis of variance (ANOVA) of a repeated measures design was used to examine the interaction between the groups and pre to post gains. As can be seen in Table 2 and Figure 3, posttest scores for both experimental and control groups were similar. In Teacher 2's experimental, the pretest scores in math were

Table 2

Descriptive Statistics for Pre and Post Math Achievement

	N	Pre	SD	Post	SD
Teacher 1					
Experimental	58	31.47	16.63	65.90	11.45
Control	55	20.47	12.69	60.40	13.19
Teacher 2					
Experimental	52	12.75	7.55	59.92	10.51
Control	55	22.89	13.73	65.56	8.91

significantly lower than for those in Teacher 1's group. One possible explanation for the difference could be the number (26%) of Learning Disabled (LD) students in this classroom. The mean pretest score on math achievement for these students was 7.75 and the resulting posttest mean was 53.67.

As can be seen in Table 3, there was a significant interaction between teachers for the experimental and control group (p <.001). This is supported by the combination of the time, main effect, and the means. Because the pretest scores for Teacher 2 in the experimental group were significantly lower than other groups, yet posttest scores were similar, a one-way post hoc analysis was run to isolate the differences between groups due to the significant 3-way interaction. Table 4 indicates that students in Group 3 (T2 control) made significantly higher gains (p < .05) in achievement than Group 2 (T1 experimental); that Group 4 (T2 experimental) made significantly higher gains (p <.05) than Group 1 (T1 control) or Group 2 (T1 experimental).

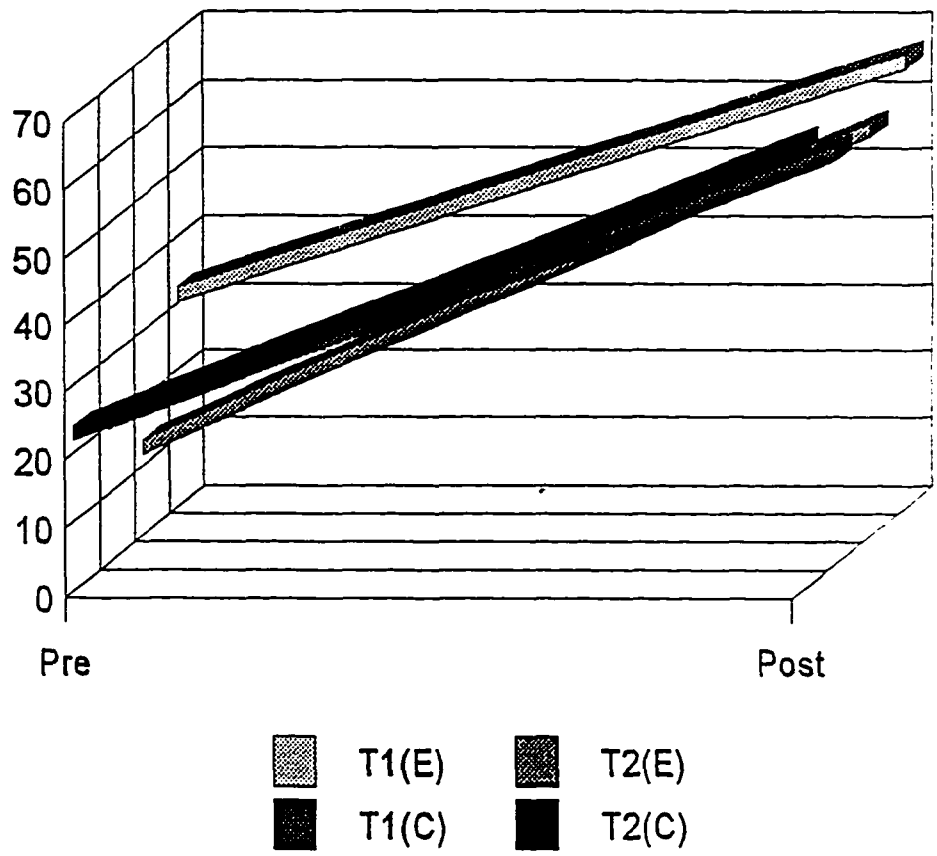

Figure 3. Comparison of pre- and post-test achievement.

Table 3

ANOVA Summary Table for Achievement

Between-subject effects					
Source of variance	SS	DF	MS	F	Sig. of F
Teacher	2,099.01	1	2,009.01	8.98	0.033
Type	3.44	1	3.44	0.02	0.901
Teacher by type	7,148.99	1	7,148.99	31.94	0.001
Within-subject effects					
Time	185,094.39	1	185,094.39	2,501.94	0.001
Teacher by time	1,646.60	1	1,646.60	22.26	0.001
Type by time	6.81	1	6.81	0.09	0.762
Teacher by type by time	686.01	1	686.01	9.27	0.003

Table 4

Post Hoc ANOVA of Math Gains

	Mean differences			
	2	1	3	4
	T1 (E)	T1 (C)	T2 (C)	T2 (E)
Group	$\bar{x}$ = 34.43	$\bar{x}$ = 39.93	$\bar{x}$ = 42.67	$\bar{x}$ = 47.55
2 T1 (E)				
1 T1 (C)	5.5			
3 T2 (C)	*8.24	2.74		
4 T2 (E)	*13.12	*7.62	4.88	

*Indicates significant difference at $p<.05$.

Results for Hypothesis II. There will be no statistically significant difference (p <.05) in math grades between the sixth-grade students who have received and followed their personal learning-styles prescription and students who have not received a learning-styles prescription.

To examine differences in attitudes between students who used their personal learning-styles prescription and those who used traditional study skills, an analysis of variance (ANOVA) was used. As can be seen in Table 5 and Figure 4, the posttest SDS attitudinal results for both experimental and control groups were similar. Table 6 describes a significant interaction between teachers for the experimental and control group (p <.001). Although attitudes about the instructional program were examined in the model and a significant 3-way interaction was observed for teacher, type of teaching style used (experimental and control) and changes over time (p < .008), post hoc analyses were not sensitive enough to determine the exact location this occurred.

Table 5

Descriptive Statistics for Pre and Post Attitude

	N	Pre	SD	Post	SD
Teacher 1					
Experimental	58	26.78	9.94	22.86	8.49
Control	55	32.04	9.58	32.13	12.46
Teacher 2					
Experimental	52	29.65	9.70	28.73	11.36
Control	55	26.24	9.81	22.06	7.44

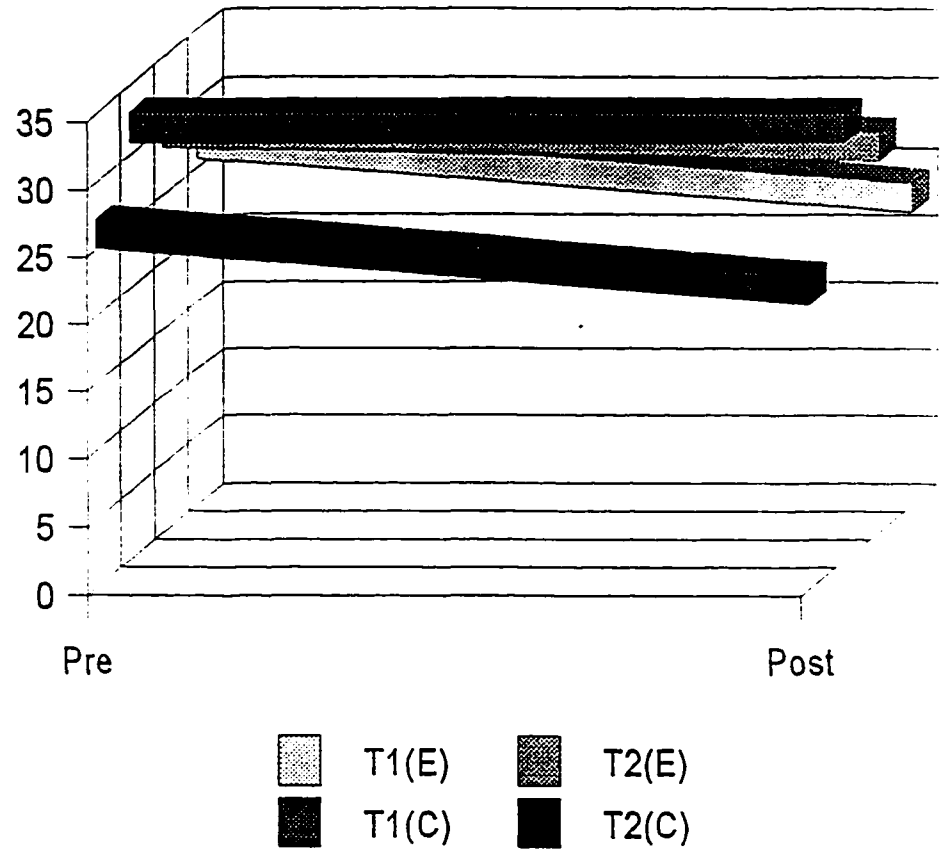

Figure 4. Comparison of pre- and post-attitudinal survey.

Table 6

ANOVA Summary Table for Attitude

Source of variance	SS	DF	MS	F	Sig. of F
Between-subject effects					
Teacher	346.47	1	346.47	2.34	0.127
Type	134.55	1	134.55	0.91	0.341
Teacher by type	4,139.88	1	4,139.88	28.02	0.001
Within-subject effects					
Time	545.05	1	545.05	10.94	0.001
Teacher by time	11.29	1	11.29	0.23	0.635
Type by time	3.77	1	3.77	0.08	0.784
Teacher by type by time	360.84	1	360.84	7.24	0.008

CHAPTER V

Summary of Findings, Conclusions, Implications, and Recommendations for Further Study

Introduction

The ongoing comparison of the math achievement of American students with students in other countries is likely to continue. The cost and consequences of the high number of at-risk and dropout students have been major concerns for parents and educators (Bauer, 1991; Carpenter et al., 1980; Dunn & Griggs, 1995; National Council of Teachers of Mathematics, 1995; Smith, 1995). Because American students consistently score lower in math compared with students of other nations, the demand for better instructional strategies to improve achievement has accelerated. Despite the implementation of programs to improve math instruction, many students continue experiencing academic difficulty and/or failure in math during their middle school years (Hodges, 1985; Maeroff, 1981; National Council of Teachers of Mathematics, 1995; Willoughby, 1970).

The purpose of this research study was to examine the effects of homework prescriptions based upon individual learning-style preferences on sixth-grade students' achievement and attitude toward mathematics. Two instruments, the LSI and the SDS, were used to diagnose and prescribe students' learning-style preferences and assess their attitudes toward the homework approach. Both instruments were found to be valid and

reliable for use in this study. This chapter presents a summary of the findings of the study, conclusions, implications for leadership regarding the significance of the findings, and recommendations for math-teaching practice and future research.

Summary of the Findings

The effect of teaching individuals differentially by providing information based on their learning style strengths was examined in this research study. The study setting was a suburban middle school with an enrollment of 937 students in grades 6 to 8, of which, 220 sixth-grade math students were selected to participate in this study. One-half were assigned to the control group, and the remaining half to the experimental group. Both groups remained in their intact classrooms. Academic ability within each group ranged from the gifted to learning disabled or at-risk students. The initial analyses of the mean scores for all groups at the time of pretesting achievement for math indicated similarity, with the exception of the experimental group in the classroom of Teacher 2, which was significantly lower than other groups. One possible explanation for this is that 26% of the students in this classroom were classified as LD. Yet, posttest scores for Teacher 2 were similar to the other groups. The post hoc analysis of variance (ANOVA) indicated significant difference ($p < .05$) between the math gains of students in the classroom of Teachers 2 and 1, but no difference was noted due to the homework prescription. Thus, the findings of this study revealed no significant changes in achievement or attitude as a result of the homework prescription.

Conclusions

A careful examination of student responses to each of the five stimuli by subscale on the Learning Style Inventory was conducted to determine reasons for the significant

interaction between teachers for the experimental and control groups over time (p <.001). The analysis indicated that >75% of total students in this study were global/simultaneous learners, and >85% of the students' strongest learning modality was tactual/ kinesthetic.

Research conducted by Hill (1987) and Treflinger (1992), showed that students have an innate ability to use their modality preferences when conditions promote and stimulate such activities. Therefore, students tend to accommodate these strengths in learning environments that encourage and foster self-awareness. Global students, in particular, have a preference for unconventional classroom designs (Dunn et al., 1992). They gravitate toward ergonomically compatible seating without teacher directives. This response was noted by Andrews (1991) as settings that promoted and stimulated learning. The classrooms of Teachers 1 and 2 in this study offered both formal and informal environments. Although having the same teacher provide instructions for both experimental and control students can reduce the teacher effect on achievement, in this case, there is concern that the overall instructional styles of the teachers were confounding variables.

It was surprising that both the experimental and control groups performed similarly on the posttest of mathematics achievement. In previous research conducted in elementary schools (Weinberger, 1983), secondary schools (Bauer, 1991; Kroon, 1985; Marino, 1993; Martini, 1986; McFarland, 1990; Moore, 1992; Dunn, Bruno, et al., 1990), and colleges (Lenehan et al., 1995), the use of homework prescriptions resulted in significantly higher achievement and attitude gains when students were assigned individualized homework prescriptions to complement their unique learning style characteristics.

The significant difference in achievement gains in math between Teachers 2 and 1 must be attributed to the global teaching style of Teacher 2 and the matching of instructional resources that accommodated the needs of global learning students. In additional findings, anecdotal observations revealed that Teacher 2 taught more consistently with strategies congruent to the students' learning-style preferences and introduced the students to resources such as Flip Chutes, Pic-A-Holes, Task Cards, or Floor Games, that permitted them to learn while being actively engaged in alternatives to conventional schooling. The teacher's focus on teaching through students' learning style strengths rather than on their perceived intelligence and her pacing ability allowed this group to teach themselves and each other with tactual and kinesthetic resources, as prescribed by their individualized homework prescriptions. The particularly effective outcome on the experimental group, which contained a large number (26%) of learning disabled students, indicates that many officially classified as LD in math have the potential to master the same subject matter as do students who are gifted (Yong & McIntyre, 1992). In an informal interview with the special education support teacher, who assisted Teacher 2 with inclusion students, she stated that she had never seen a teacher who better addressed the needs of *each* student.

Although the students' attitudinal survey remained neutral from pretest to posttest administration, students were overheard discussing the overall positive outcome in their academic performance in other disciplines, as well as in math, when they used their individualized homework prescriptions. Once the study was concluded, some of the students reported during informal interviews that, when they discontinued the use of their prescriptions, they experienced a decrease in academic achievement.

One reason no significant difference between the experimental and control groups was noted was that each of the two teachers taught both groups. It is a natural tendency for good teachers to use what they think will work for students, even in the control groups. Therefore, there may have been cross-group contamination.

Implications for Leadership

The findings of this study have significant implications for those in decision-making roles within the schools. All principals, and particularly middle and high school principals, are aware of the mounting expectations for them to serve as the instructional leaders of the schools (Dunn & Frazier, 1990). The educational stakeholders place matters of teaching and learning squarely on the principals' shoulders. Supervision, staff development, planning, and program evaluation are indisputably the principals' responsibilities. Such leadership shapes teachers' instructional performance and student outcomes.

Research indicates that use of teaching strategies that are congruent to students' learning styles increases students' academic achievement and attitudes (Cafferty, 1980; Dunn, Beaudry, & Klavas, 1989; Stone, 1992). With the diversity of students found within the classrooms today, especially with the inclusion of special education students, the theoretical and practical basis of addressing the individual learning style of each student becomes more important. Educational leaders must reexamine the teaching-learning process on a regular basis to equip personnel with skills and resources to build an instructional process in a relatively short period of time that responds directly to the needs of each student (Dunn & Dunn, 1978).

Limitations and Recommendations for Further Research

This research study was limited by the learning style characteristics and varying degrees of achievement levels (learning disabled, average, and gifted) of the participating sixth-grade mathematics students attending school during the 1995-96 academic year in an upper socioeconomic, suburban school district in Alabama. The progressive educational philosophy of the middle school in this study and its modifications to achieve educational excellence has directly influenced student attitude toward learning. Such trends as a rotating schedule for instructional periods to accommodate student/teacher time preferences and energy levels has routinely increased task efficiency, motivation, and achievement. The attempts by this middle school to match math classes to students' chronobiological preferences and provide classrooms that offer a colorful, aesthetically appealing instructional setting with formal and informal furniture, may have aroused concentration and significantly improved attitudes toward learning prior to the implementation of the treatment.

Teaching style is another element for careful examination that has an impact on both achievement and attitude. Both Teachers 1 and 2 incorporated varied instructional techniques in an attempt to reach all students. Those who suggest that children should learn to adapt to their teachers' styles or vice versa disregard the biological nature of style (Cafferty, 1980). Both students and teachers routinely demonstrate remarkable resistance to such change. In terms of the global teaching style of Teacher 2, observations and informal interviews indicated a high level of frustration as she sought to adapt her instructional techniques for the control groups to avoid suggestions that might contaminate the results.

Although treatment procedures were carefully monitored, critics of in-class studies would cite the difficulties of contamination within teacher/class effect. Therefore, it is important to recognize that this arrangement should be considered in future studies. The findings of this study indicate that those elements of learning style that are inherent due to chronobiology can enhance educational achievement, but those elements that are developed through experience must be provided through responsive instruction as educators meet the needs of diverse student populations.

Future researchers should consider the following issues when designing studies:

1. Schools should have no intact programs that could contaminate the homework design treatment.

2. Effects of matching and mismatching teaching styles to student styles in a middle school math setting can significantly affect performance.

3. Researchers should conduct longitudinal studies on the effects of homework prescription on achievement and attitudes between middle schools.

4. Researchers should examine the academic achievement and attitudes of at-risk students in tutorial programs designed to provide resources matched to individualized homework prescriptions.

5. Researchers should consider the attitude and achievement of middle school students toward math individualized homework prescription based upon gender.

In conclusion, school districts can protect themselves against the increasing number of educational malpractice suits by accurately identifying students' learning preferences. Individualization of instructional techniques is essential if instruction is to

improve to assist *all* students in reaching their ultimate potential—to discover those talents and capabilities of which they are unaware.

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APPENDIX A

LEARNING STYLE INVENTORY[1]

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LEARNING STYLE INVENTORY
ANSWER SHEET
GRADES 5-12

DUNN, DUNN AND PRICE

USE NO. 2 PENCIL ONLY

- USE NO. 2 PENCIL ONLY.
- DO NOT FOLD OR STAPLE THIS FORM.

Read each statement and decide to what extent you would agree or disagree with that statement if you had something new or difficult to learn. Mark (SD), if you strongly disagree, or (D), disagree, or (U), uncertain, or (A), agree, or (SA), strongly agree, as the response that best describes how you feel most of the time. Some of the questions are repeated to help make the inventory results more reliable. Answer the repeated questions the same as you did the first time you read the question. Give your immediate or first reaction to each question. Please answer all the questions on both sides of form.

Form No. 12

1. I study best when it is quiet.
2. I like to make my parents happy by getting good grades.
3. I like studying with lots of light.
4. I like to be told what to do when my teacher gives me an assignment.
5. I concentrate best when I feel warm.
6. I study best at a table or desk.
7. When I study I like to sit on a soft chair or couch.
8. I like to study with one or two friends.
9. I like to do well in school.
10. I usually feel more comfortable in warm weather than I do in cool weather.
11. Things outside of school are more important to me than my school work.
12. I am able to study best in the morning.
13. I often have trouble finishing things I ought to do.
14. I have to be reminded often to do something.
15. I like making my teacher proud of me.
16. I study best when the lights are shaded.
17. When I really have a lot of studying to do I like to work alone.
18. I do not - .t, drink, or chew while studying.
19. I like to sit in a straight chair when I study.
20. Sometimes I like to study alone and sometimes with friends.
21. I remember instructions better when I read, rather than when I hear them.
22. I think better when I eat while I study.
23. I like an outline for how I should do my school work.
24. I often nibble something as I study.
25. It's hard for me to sit in one place for a long time.
26. I remember things best when I study them early in the morning.
27. I like to learn by talking with people.
28. I hardly ever finish all my work.
29. I prefer to do my homework in the afternoon.
30. I really don't care much for school.
31. I like to feel what I learn inside of me.
32. It is hard for me to concentrate when there is noise.
33. I like to learn something new by talking rather than reading about it.
34. At home I like to study with a lamp on

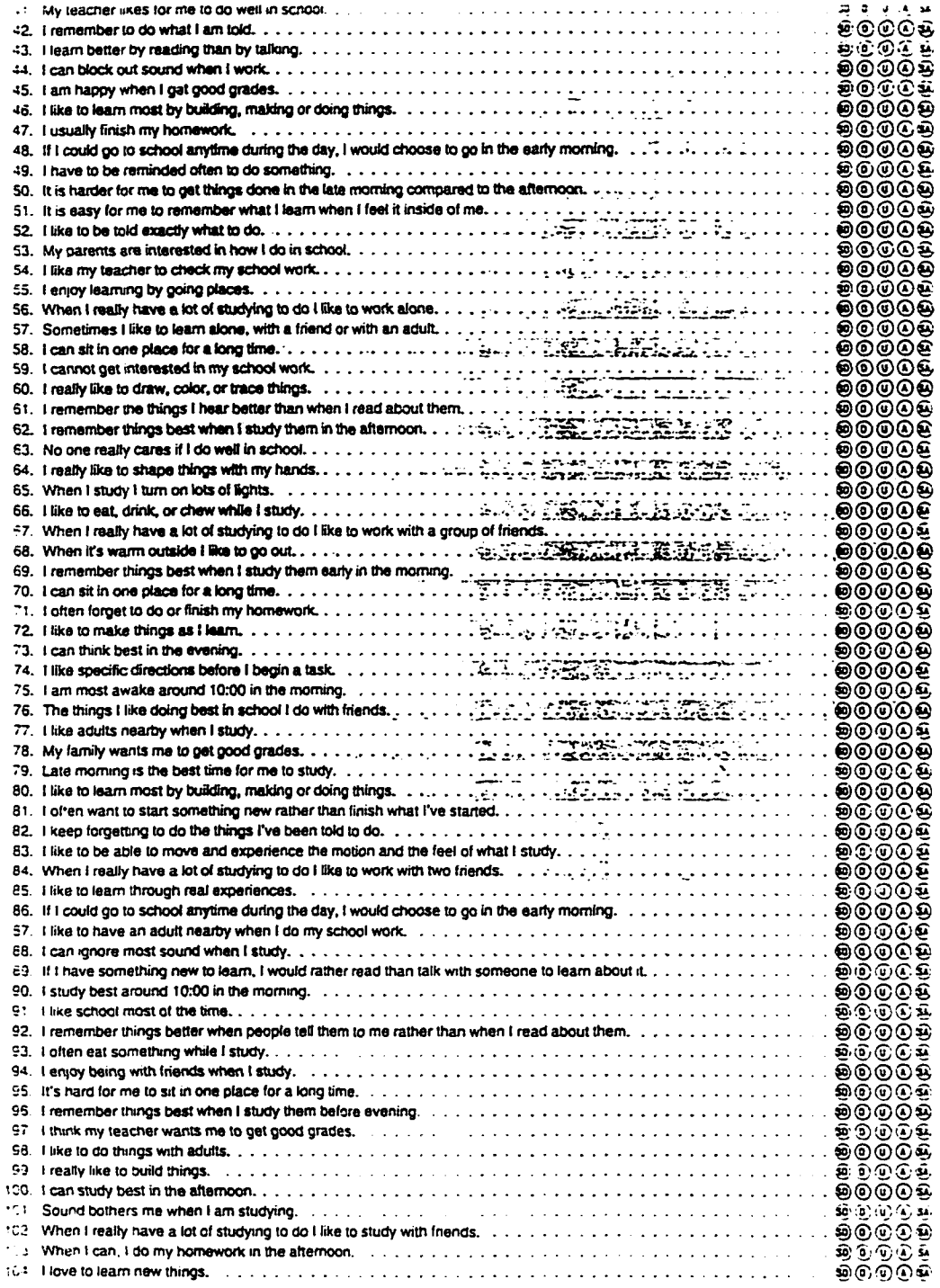
SEX: FEMALE / MALE

IDENTIFICATION NUMBER

BIRTHDAY: YEAR MONTH

SPECIAL CODES

GRADE OR EDUCATION COMPLETED



APPENDIX B

SEMANTIC DIFFERENTIAL SCALE

Name _____

Date _____

SEMANTIC DIFFERENTIAL SCALE (SDS)

My reactions to: Feeling of success in math

Directions: Make a check in one of the five spaces between the pairs of opposite meaning words. Choose the space closest to the word that indicates your reaction to your feelings of success in math. A check in the middle space indicates a neutral reaction.

* *

Example:

HELPFUL _X_ ___ ___ ___ ___ NOT HELPFUL

* *

CONFUSED	___	___	___	___	___	CLEAR-MINDED
ENGERGETIC	___	___	___	___	___	TIRED
NERVOUS	___	___	___	___	___	CALM
STRONG	___	___	___	___	___	WEAK
TENSE	___	___	___	___	___	RELAXED
WONDERFUL	___	___	___	___	___	TERRIBLE
SHAKY	___	___	___	___	___	STEADY
CONFIDENT	___	___	___	___	___	UNCERTAIN
BAD	___	___	___	___	___	GOOD
PEACEFUL	___	___	___	___	___	FRUSTRATED
DULL	___	___	___	___	___	SHARP
SUCCESSFUL	___	___	___	___	___	UNSUCCESSFUL

APPENDIX C

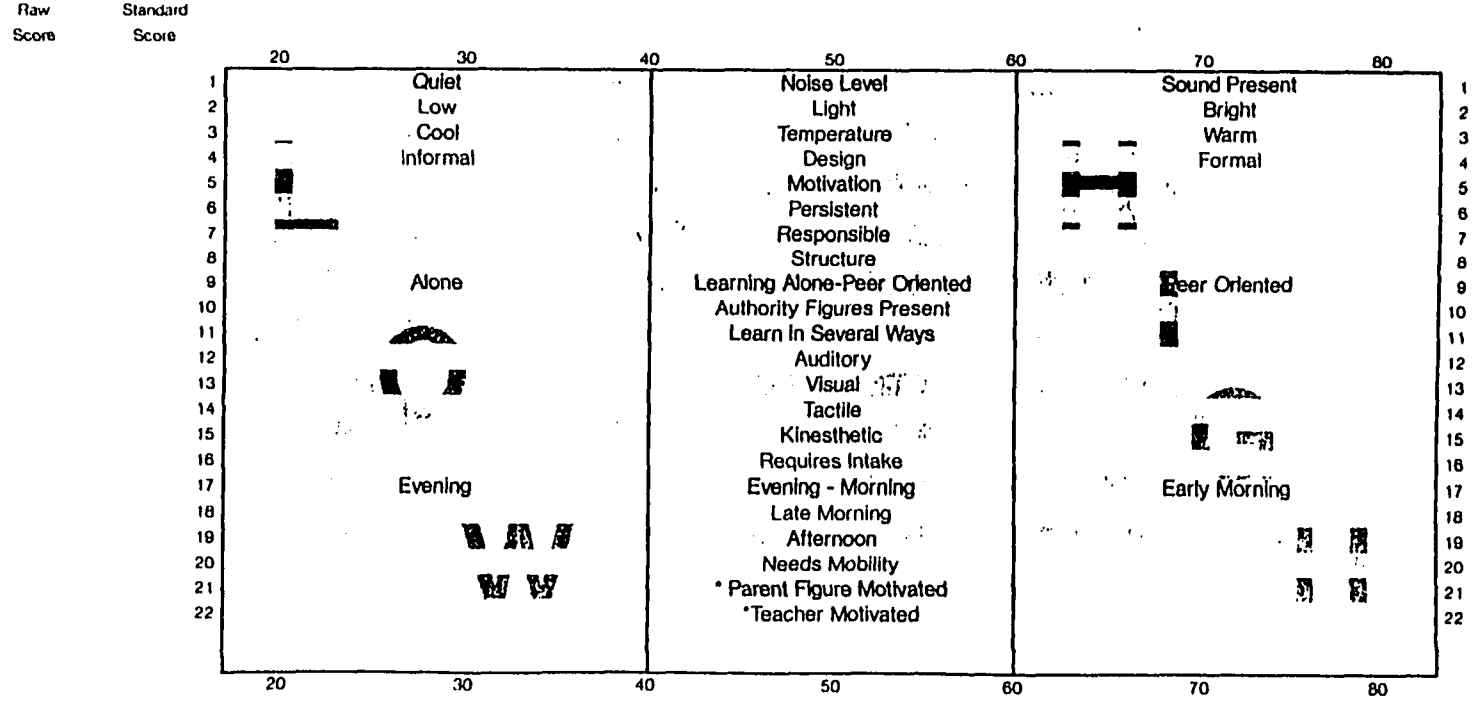
LEARNING STYLE PROFILE

INDIVIDUAL PROFILE

Name: Sex: Year in School: Date of Birth: Yr / Mo I.D. No.:

Group Identification: Special Code: Date: Group No.:

PREFERENCE SUMMARY



APPENDIX D

HOMEWORK PRESCRIPTION

Name John Grade 4
Sex Male Teacher Mith

SOUND	34	AUDITORY	77
LIGHT	23	VISUAL	55
TEMP	45	TACTILE	44
DESIGN	23	KINESTHETIC	33
MOTIVATION	56	INTAKE	23
PERSISTENCE	33	MORNING	43
RESPONSIBLE	44	LATE MORNING	54
STRUCTURE	23	AFTERNOON	43
ALONE	12	MOBILITY	23
AUTHORITY	45	PARENT	43
VARIETY	66	TEACHER	33

SOUND You usually need quiet when learning something new or when you are studying or doing homework. You should not be within hearing distance of a radio or television.

LIGHT You usually do your best studying in very low light. Consider indirect or subdued lighting when you are planning your work space at home. Bright light can create tension or distract you. On a bright, sunny day do not study or do your homework near a window. Plants or dividers can be used to block out or diffuse the glare for you.

DESIGN You like to do homework in an informal atmosphere. Study on a pillow, couch, carpet, bed or lounge chair, since you are not comfortable in a conventional classroom setting. You find it difficult to concentrate at a hard desk or chair.

PERSISTENCE
Occasionally you may start homework assignments and not complete them. You may want to "take breaks", doing a little at a time, but returning after five minutes and, eventually, finishing the assignment on time. It's good to try doing a little at a time, but it is important to get back to the task in five-minute intervals so that you do finish. (Besides, you'll learn more than before and get your folks - and your teacher - "off your back"!)

STRUCTURE
When doing homework or studying, you become irritated when you are told exactly what to do and how to do it. You prefer to make your own choices and decisions. You often begin assignments before detailed directions are given. You usually organize things in your own way and require little structure. You should, however, ask your teacher's permission before you decide to do a homework assignment differently. (Explain what you would like to do and why you would like to try it that way!)

APPENDIX E

VERIFICATION FORM

Student's Use of Learning Style Prescriptions

Student's Name: _____ Period: _____

Week #1

Day	Mon	Tues	Wed	Thur	Fri
Date					
	Parent Signature	Parent Signature	Parent Signature	Parent Signature	Parent Signature

Week #2

Mon	Tues	Wed	Thur	Fri
Parent Signature	Parent Signature	Parent Signature	Parent Signature	Parent Signature

Week #3

Day	Mon	Tues	Wed	Thur	Fri
Date					
	Parent Signature	Parent Signature	Parent Signature	Parent Signature	Parent Signature

Week #4

Mon	Tues	Wed	Thur	Fri
Parent Signature	Parent Signature	Parent Signature	Parent Signature	Parent Signature

Put a Check Mark Under The Day(s) The Learning Style Prescription Was Used.

APPENDIX F

STUDENT/PARENT CONSENT FORM

APPENDIX F
Student and Parent Consent Form

Mrs. Mary White, a sixth grade math teacher at Oak Mountain Middle School, will be conducting a study as a part of the requirement for the completion of the Doctor of Education degree. The study will take place during the first semester of the 1995-96 school year. The study will help students understand how they learn and provide suggestions of ways to do homework more effectively. Students will take the Semantic Differential Scale prior to the beginning of the study to determine attitudes toward math as they enter the sixth grade. The Learning Style Inventory will be administered to identify the conditions under which each person is most likely to concentrate on, learn, and remember new and difficult academic information. With the use of a Homework Disk or software package students will be provided individual suggestions for doing homework and studying in ways that complement their personal learning styles. Prior to implementing the study a pretest will be used to determine existing knowledge on new mathematical content.Once the study is completed students will take a posttest to determine any difference in achievement and attitude as a result of the homework prescription. All materials will be discarded at the conclusion of the study and complete anonymity maintained throughout the study. We are requesting permission for sixth grade students to participate in this study.

In order for a student to participate in this study we need the student, his/her parent or guardian, and witness read and sign this form and return as soon as possible.

Participation is voluntary.
If the student does not wish to participate in the study, it will have no effect on the student's grade.
There will be no risk, inconvenience, or discomfort to students participating in the study.
No cost is required in participation.
A student may withdraw from the study, or be withdrawn from the study by a parent or guardian, at any time.
Confidentiality and anonymity will be protected. Codes will be assigned to each participant so that only Mrs. White will know the identity of participants. Students and family names will not appear in any report.

Mrs. White will be happy to answer any questions you may have. She is available at Oak Mountain Middle School, 980-3660. You may also call Mrs. White's advisor at the University: Dr. Janice Herman, 934-4892.

You are making a decision whether or not to have the student participate in this study. Your signature indicates that you have decided to allow the student to participate, that you have read the information provided which explains the study, and that you have received a copy of this consent form and the explanation.

SIGNATURE OF STUDENT	DATE
SIGNATURE OF PARENT OR GUARDIAN	DATE
WITNESS	DATE
SIGNATURE OF INVESTIGATOR	DATE

APPENDIX G

LETTER TO PARENTS

Dear Parents,

My classes are about to embark on a journey through the *Land of the Unknown- Algebraic Equations.* To better equip them for this experience I would like to provide suggestions for studying homework based upon their individual learning styles. On Tuesday, November 28, at 7:00 p.m. I would like to meet with the parents of my 4th and 6th periods in the cafeteria to share some pertinent information which will enhance this mathematical experience.

I am thrilled to work with your child in this endeavor so that they may be better equipped to meet the challenges of math in future years. Please sign below if you will be able to attend and return it to me as soon as possible.

Thank you for your participation.

Sincerely,

Jane Walsh

I will be able to attend this informational session.

_____ yes _____ no

Student _____

Parent Signature _____

APPENDIX H

PARAGRAPH COMPLETION

Paragraph Completion

Student # _____
Period _____

During our study of algebraic equations I felt _____.

Explain. _____

_____.

Other sources of assistance in learning this information included:

_____

_____.

Paragraph Completion

Student # _____
Period _____

During our study of algebraic equations the use of my learning-style homework prescription allowed me to _____

_____

_____.

I felt it _____

_____

_____.

APPENDIX I

INSTITUTIONAL REVIEW BOARD FOR HUMAN USE APPROVAL

UAB THE UNIVERSITY OF ALABAMA AT BIRMINGHAM
Office of the Institutional Review Board for Human Use

FORM 4: IDENTIFICATION AND CERTIFICATION OF RESEARCH PROJECTS INVOLVING HUMAN SUBJECTS

THE INSTITUTIONAL REVIEW BOARD (IRB) MUST COMPLETE THIS FORM FOR ALL APPLICATIONS FOR RESEARCH AND TRAINING GRANTS, PROGRAM PROJECT AND CENTER GRANTS, DEMONSTRATION GRANTS, FELLOWSHIPS, TRAINERSHIPS, AWARDS, AND OTHER PROPOSALS WHICH MIGHT INVOLVE THE USE OF HUMAN RESEARCH SUBJECTS INDEPENDENT OF SOURCE OF FUNDING.

THIS FORM DOES NOT APPLY TO APPLICATIONS FOR GRANTS LIMITED TO THE SUPPORT OF CONSTRUCTION, ALTERATIONS AND RENOVATIONS, OR RESEARCH RESOURCES.

PRINCIPAL INVESTIGATOR: WHITE, MARY E.

PROJECT TITLE: EFFECTS OF HOMEWORK PRESCRIPTIONS BASED UPON INDIVIDUAL LEARNING-STYLE PREFERENCES ON THE ACHIEVEMENT AND ATTITUDE TOWARD MATHEMATICS OF SIXTH-GRADE STUDENTS

_____1. THIS IS A TRAINING GRANT. EACH RESEARCH PROJECT INVOLVING HUMAN SUBJECTS PROPOSED BY TRAINEES MUST BE REVIEWED SEPARATELY BY THE INSTITUTIONAL REVIEW BOARD (IRB).

__X__2. THIS APPLICATION INCLUDES RESEARCH INVOLVING HUMAN SUBJECTS. THE IRB HAS REVIEWED AND APPROVED THIS APPLICATION ON OCTOBER 11, 1995 IN ACCORDANCE WITH UAB'S ASSURANCE APPROVED BY THE UNITED STATES PUBLIC HEALTH SERVICE. THE PROJECT WILL BE SUBJECT TO ANNUAL CONTINUING REVIEW AS PROVIDED IN THAT ASSURANCE.

_____ THIS PROJECT RECEIVED EXPEDITED REVIEW.

__X__ THIS PROJECT RECEIVED FULL BOARD REVIEW.

_____3. THIS APPLICATION MAY INCLUDE RESEARCH INVOLVING HUMAN SUBJECTS. REVIEW IS PENDING BY THE IRB AS PROVIDED BY UAB'S ASSURANCE. COMPLETION OF REVIEW WILL BE CERTIFIED BY ISSUANCE OF ANOTHER FORM 4 AS SOON AS POSSIBLE.

_____4. EXEMPTION IS APPROVED BASED ON EXEMPTION CATEGORY NUMBER(S)_____.

DATE: OCTOBER 11, 1995

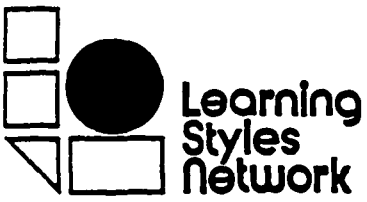
K. Randall Young

K. RANDALL YOUNG, JR., M.D.
INTERIM CHAIRMAN OF THE
INSTITUTIONAL REVIEW BOARD

The University of Alabama at Birmingham
1170R Administration Building • 701 South 20th Street
Birmingham, Alabama 35294 0111 • (205) 934-3789 • FAX (205) 975-5977

APPENDIX J

AUTHORS' CONSENT TO REPRODUCE COPYRIGHTED WORKS



The Center for the Study
of Learning and Teaching Styles

PROFESSOR RITA DUNN, Ed.D., Director

Angela Klavas, Ed. D., Assistant Director
Joanne Ingham, Ed. D., Director of Adult Learning
and Corporate Training

August 9, 1995

Mary White
2428 Brook Run Circle
Birmingham, Alabama
35244

Dear Mary:

You have my permission to use the Learning Styles Model in your research. You don't need permission to use the Homework Prescription disk. It is sold here at the Center.

If you need further assistance, please do not hesitate to let me know.

Sincerely,

Professor Rita Dunn, Ed.D.

RD:mml

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August 29, 1995

Mary E. White
2428 Brook Run
Birmingham, AL 35244

Dear Mary:

Yes, I know of your work in the area of learning style and with Ken Dunn. I want to give you permission to enclose a copy of the LSI in the appendices of your dissertation. I hope you will be willing to send me an abstract of your dissertation. I am sorry you did not get this before because I do have your previous fax.

I dictated a letter and I do not know what happened to it.

Sincerely,

Gary E. Price

GRADUATE SCHOOL
UNIVERSITY OF ALABAMA AT BIRMINGHAM
DISSERTATION APPROVAL FORM

Name of Candidate Mary Elizabeth White

Major Subject Educational Leadership

Title of Dissertation Effects of Homework Prescriptions Based Upon Individual Learning-Style Preferences on the Achievement and Attitude Toward Mathematics of Sixth-Grade Students

Dissertation Committee:

Dr. James McLean	, Chairman	
Dr. Harold Bishop		
Dr. Gypsey Abbott		
Dr. Dave Dagley		
Dr. MaryAnn Manning		

Director of Graduate Program

Dean, UAB Graduate School

Date 6/13/96