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An Investigation of the Preferential Learning Strategies, Modality Preferences, and Academic Performance among Eighth-Grade Students

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AN INVESTIGATION OF THE PREFERENTIAL LEARNING STRATEGIES, MODALITY PREFERENCES, AND ACADEMIC PERFORMANCE AMONG EIGHTH GRADE STUDENTS

by

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The purpose of this study was to investigate differences among students' preferential learning styles, (preferred learning strategies and instructional modality), and their academic achievement. The hypothesis was tested not only for the total sample population but also for the subgroups of: gender (male, female) and ethnicity (Anglo, Hispanic, Asian).

In order to accomplish this, two self-reporting assessement instruments, The Hard to Reach/Hard to Teach (HTR/HTT) and the Learning Channels Modality Inventory were administered to 200 eighth graders to determine learning style and instructional modality preferences: abstract-sequential (AS); concrete-sequential (CS); abstract-random (AR); concrete-random (CR); auditory (A); visual (V); kinesthetic-tactual (KT). The sample population was selected by stratified-random sampling based upon GPA (4.00-3.50; 3.49-2.50; 2.49-1.50; 1.49-0.00) and by systematic

sampling within each category. Students identified as gifted or enrolled in special education, or ESL classes were excluded. Academic performance was measured by grade point average (GPA) and standardized Comprehensive Test of Basic Skills (CTBS) scores.

Data were analyzed and the hypotheses were tested using One-Way ANOVA procedures with post hoc Tukey-Kramer tests. A two-tailed test at the .05 alpha level was used to determine statistical significance.

Findings from this study supported the hypothesis. Significant academic variances were found among students' preferential learning styles and modality groups within the total population as well as within specific subgroup groups. Statistically significant academic variances were observed between the highest achievers (left brain dominant, AS/A learners) and the lowest achievers (right brain dominant, CR/KT learners). The mean score pattern of achievement ranged from highest to lowest: learning styles (AS, AR, CS, CR); modalities (A, V, KT). Students who preferred abstract learning strategies demonstrated higher achievement levels than those who preferred concrete strategies. Among the various subgroup populations, the highest group mean scores were earned by: Asians, Anglos, and females with AS/A learning preferences. The lowest group mean scores were demonstrated by: Anglo males and Hispanic males with CR/KT learning

preferences. The majority of females preferred left brain dominant/sequential learning styles (AS, CS) while the majority of males expressed a preference for right brain dominant/random styles (CR, AR). The majority of females preferred abstract learning styles (AS, AR) to concrete ones. The majority of males preferred concrete styles (CR, CS) to abstract ones. More females than males preferred auditory modality. More males than females expressed a preference for visual.

This research confirms that there are significant variances in academic achievement among students with differing learning style and instructional modality preferences. The concern raised is whether or not some students are advantaged or disadvantaged in the learning environment by congruency or incongruency of teaching/learning styles. Additional research is needed in order to determine to what degree matching teaching/learning styles may improve academic achievement among learners now identified at risk.

DEDICATION

This study is dedicated to my two children, Brian John and Bobbie Sue, whose demonstration of contrasting academic achievement and uniquely different learning styles compelled me to conduct this research project.

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CHAPTER 1

STATEMENT OF THE PROBLEM

Introduction

The roots of our government are deeply embedded in the belief that an educated electorate is critically essential for sustaining a healthy and vital democratic society. In fact, our society so values education that every state has legislated that all citizens be granted the right to a free education. Educators throughout our society are charged with the responsibility of delivering the best educational experience available for all students. In this common endeavor, teachers ". . . share a noble goal. It is to educate everyone." (Wittrock, 1988, p. 287).

For years, educators have been challenged and frustrated by their inability to develop the academic potential of many of their students. Over the years, these students have been categorized as low achievers. They are regarded as hard to reach and hard to teach students. In the past, most educators have labored under the widespread belief that these students who have not learned simply have not paid attention, or lacked ability, and therefore, did not benefit from the educational environment provided them (Dunn & Dunn,

1978). The traditional view, by educators and the public as well, has been that it is primarily the student's responsibility to achieve academic success. Failure was viewed to be the fault of the learner (Barbe & Swassing, 1979; Dunn & Dunn, 1978).

The decade of the 1970's witnessed an apparent reversal in the public's attitude toward the educational system. Public opinion today is focusing on the individual's right to expect a positive and productive academic experience from the school system. This change in public opinion has been prompted in part by a series of court actions related to functional illiterates who have earned diplomas. Legislative actions in California, as well as in other states, have forced schools to be more accountable for student performance in order to secure and maintain government funding and support (Dunn & Dunn, 1978). As a result, the schools, their teachers and managers of the instructional programs, have assumed a greater degree of responsibility for student achievement and/or lack of achievement.

Over ten years of research in the field of learning styles have gradually prompted educators to recognize why some students may fail to achieve. As early as 1976, Madeline Hunter (1976) suggested that many students fail to achieve because the traditional

school system persists in beaming instruction by using methodology which is incongruent with many students' preferred learning styles and modality strengths. Barbe & Swassing (1979) were among the first educators to advocate that the child is not at fault if he/she fails to learn. Rather, they suggested that the educator has failed to find the key to how the child learns. According to Barbe and Swassing (1979), the key to academic success often lies in the identification and utilization of the individual student's modality strength(s) in the learning process. Dunn & Griggs (1988) charged that the school system is ineffective because it fails to adequately respond to the diversity of individual learning styles. Wittrock advocated that educators' ". . .noble aspiration is to improve education through knowledge of learning strategies" (Wittrock, 1988, p. 289).

The Issue

The issue then becomes: Are low achievers disadvantaged in the traditional educational system? Do their preferential learning styles and modality strengths conflict with the predominantly utilized instructional methodology and preferred teaching styles of most educators? Noted researchers and educators in

the field say the answer is "Yes!" (Barbe & Swassing, 1979; Butler, 1985; Dunn & Dunn, 1978; Dunn & Griggs, 1988; Gregorc, 1979; Griggs, 1988; Guild & Garger, 1985; Hunter, 1976; Keefe, 1989; Rubenzer, 1985; Trautman, 1979). Pursuant to this issue, various assessment instruments have been developed to identify learning style characteristics and to design instructional methodologies which capitalize on these differing learning style preferences (Butler, 1985; Dunn & Dunn, 1978; Dunn, Dunn, & Price, 1979; Edwards, 1979; Gregorc, 1977, 1979; Guild & Garger, 1985; Hunter, 1976; Keefe, 1979; McCarthy, 1980; Sanders, 1984; Vitale-Meister, 1982).

Purpose of the Study

The purpose of this study was to investigate whether or not there were significant differences among students' preferential learning styles, (preferred learning strategies and preferred instructional modality), and their academic achievement within a given sample population. The literature clearly indicates that the predominant instructional methodology in the traditional school system adheres to left brain dominant, sequential, auditory/visual presentation (Blakeslee, 1980; Butler, 1985; Cody,

1983; Durden-Smith & deSimone, 1983; Goodlad, 1988; Hirsch, 1985; Hunter, 1976; McCarthy, 1980; Restak, 1979; Rubenzer, 1985; Springer & Deutsch, 1981; Vitale-Meister, 1982; Zdenek, 1983). The literature abounds with references which suggest that the identification and utilization of individual learning preferences are the key which may open the door to educational improvement, academically transforming many underachievers into achievers (Griggs, 1988; Keefe, 1979; Letteri, 1989; O'Brien, 1989; White, 1981). Some educators suggest the importance of further implementation of these concepts in the field as a possible means of facilitating improved student achievement (Anderson & Bruce, 1979; Keefe, 1989; Rubenzer, 1985; Vigna, 1983).

There is a need for additional research in the area of learning style preferences to clearly establish whether or not those students who are failing to achieve academically, have learning styles which are incongruent with commonly utilized teaching styles and instructional methodologies (Clark-Thayer, 1987; Cupkie, 1980; Giunta, 1984). Educators need to focus more on the ways students learn rather than on what students learn. They need to be more process oriented rather than content oriented (Barbe & Swassing, 1979). One clue to helping more students achieve academic

success in our schools would seem to involve utilizing a variety of teaching styles and instructional strategies in order to realize common educational goals and objectives (Butler, 1985; Gregorc, 1979, 1979; Griggs, 1988; McCarthy, 1980).

The bottom line of any school program is student outcome (Jenkins, 1989). An instructional program which recognizes different individual learning styles and also provides appropriate instructional methodologies to accommodate for those differences will promote the desired positive student academic outcomes. This would effectively meet the legal mandates for providing equal access to knowledge for all and not just for some learners (Buzan, 1946; Dunn & Dunn, 1978; Dunn & Bruno, 1985; Goodlad, 1988; Gregorc, 1979; Griggs, 1988; Hunter, 1976; Jenkins, 1989; Keefe, 1979; Lemmon, 1985; McCarthy, 1980; NASSP, 1989; Schmeck, 1988; Thies, 1979; Vitale-Meister, 1982).

Definition of Terms

learning modality: A preferred sense (auditory, visual, kinesthetic-tactual) utilized for processing information.

auditory (A): Sensory modality characterized by hearing.

visual (V): Sensory modality characterized by seeing.

Kinesthetic-tactual (KT): Sensory modality characterized by movement, touch, physical and/or emotional feeling.

left brain dominant: Mental processing characterized by linear, sequential, logical, verbal, reality-based, temporal, symbolic, abstract modes of consciousness.

right brain dominant: Mental processing characterized by holistic, concrete, random, intuitive, non-verbal, fantasy-oriented, non-temporal, analogic modes of consciousness.

learning style: An individual's natural, preferred behavioral manner for processing information; including but not limited to, modality and learning strategy preferences.

preferential learning strategy: When given the option of choice, a particular learning activity freely selected by the learner from many available options.

cognitive learning styles as defined by Anthony Gregorc (1977, 1979) and Kathleen Butler (1985):

(a) abstract-sequential (AS): A learning style characterized by left brain processing. Preferred learning strategies focus on instructional activities which stimulate intellectual abstractions including: reason and logic; theory and concepts; ideas and

information; analysis and evaluation; intellectual problems; reading; logical outcomes; meeting-of-the minds strategies.

(b) concrete-sequential (CS): A learning style characterized by left brain processing. Preferred learning strategies focus on learning activities which are structured and reality based including: patterns and directions; details and facts; task-oriented approach; practical problems; realistic situations; hands-on approaches; real products and results.

(c) abstract-random (AR): A learning style characterized by right brain processing. Preferred learning strategies focus on learning activities which are linked to emotion-based abstractions including: interpretation, explanation, communication; thematic; metaphoric; illustrative, imaginative and relationship oriented instructional approaches.

(d) concrete-random (CR): A learning style characterized by right brain processing. Preferred learning strategies focus on learning activities which are global, open-ended, and unstructured including: problem solving;

exploration; investigation, divergent thinking; open-ended activity with freedom of choices; experiential; discovery-oriented approaches.

learning strategies: Specific learning activities generated from the works of Gregorc (1977; 1979) and Butler (1979) which are specifically reflective of one of the four learning styles (AS; CS; AR; CR) as defined and developed by the Gregorc model of cognitive learning styles.

learning style assessment: An attempt to identify an individual's preferences related to learning. The assessment of an individual's style preferences may be based upon observations, interviews, and/or the use of one or more self-reporting instruments.

learning style profile: The results of a learning style assessment which provides some type of descriptive feedback to the learner and the teacher related to how that individual may prefer to learn.

teaching style: A teacher's natural and preferred behavioral manner, including attitudes and actions, for presenting instructional information to/and for students. Teachers' preferred teaching style generally reflects their preferential learning style.

Summary

All citizenry are granted the right to a free education. However there is a great disparity in the levels of achievement demonstrated by individual students. Public opinion has become increasingly insistent that the school system provide an educational environment which insures higher levels of academic achievement for all students. Educators today recognize that it is simply not enough to offer an educational opportunity. Rather, educators must continue to create quality learning environments which will foster greater positive academic progress for all students.

Over ten years of research in the field have prompted many educators to acknowledge the existence of differing learning styles. The recognition and implementation of learning style theories appears to offer a methodology which may improve the quality and level of academic achievement for many students who are currently regarded as low achievers. Additional research is needed in the area of learning styles and academic preference. The purpose of this study was to investigate differences among students' preferential learning styles, (preferred learning strategies and modalities), and academic achievement.

CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

The notion that individual students may have distinctive preferential learning styles is not a new concept in education. However, with the notable exception of educators such as Maria Montessori and C. N. Kephart, there has been a paucity of the practical infusion of these concepts into classroom instructional methodology.

The 1970's and 1980's have witnessed considerable interest in learning styles. The literature review suggests that learning style theories have implications for practical classroom implementation. Recent research studies document efforts where learning style theories have been utilized to more effectively reach those students who have historically failed to achieve desired levels of academic success (Browers, 1987; Browne, 1986; Lynch, 1981; Smith & Holliday, 1986; Wheeler, 1988; White, 1981).

Learning Styles

Definitions

The increased interest and mounting educational research related to the topic of learning styles has generated a plethora of definitions. Initially, sorting through these various definitions tended to be confusing. However, closer analysis revealed that there are factors commonly found.

Although the terms learning styles and cognitive styles have been used synonymously in some of the literature, they are distinctively different categories and should not be used interchangeably. Blakemore (1984) notes that cognitive styles focus on the content of cognition, that is the abilities to deal with the question of "what". Learning styles refer to the manner in which learning occurs and deals with the question of "how". Learning styles are broader in definition and may include not only cognitive factors but affective, behavioral, and physiological factors as well. Learning styles have been identified and developed primarily to directly assist the educational classroom practitioners (Blakemore, 1984).

Pat Guild and Stephen Garger (1985) provide the following comprehensive definition:

> The way each of us perceives the world governs how we think, make judgments, and form values about experiences and people. Our personal perspective is our window on the world. This unique aspect of our humanness is what we call style. It is based on the fact, that as Carl Jung (1921) observed, 'besides the many differences in human psychology there are also typical differences'. . . These basic patterns in personality influence many aspects of personal and professional behavior. In general they are called personality style. When they affect learning, we refer to learning styles [italics added]. When the patterns are reflective in teaching, we call them teaching styles. And our particular management patterns are called leadership or administrative styles (p.2-3).

Guild and Garger (1985) refined their definition of learning style by providing four basic categories of style variations or differences. Style one is concerned with cognition and deals with the question: "How do I know?" Style two is concerned with conceptualization and deals with the question: "How do I think?" Style three is concerned with affect, feel-

ing, and values. It deals with the question: "How do I decide?" Style four is concerned with diversity in behavior and deals with the question: "How do I act?"

According to Hilgersom-Volk (1987) "Every human being has a unique way of perceiving, evaluating, and communicating. These differences are matters of personal style. . . In short, learning styles are unique internal processes that guide how we take in information from our environment" (p.3).

James Keefe (1979, 1987, 1989), through the NASSP publications, has widened the awareness of the concept of learning styles by promoting a practical definition for educators in the field. Keefe (1989) stated, "Learning style indicates how a student learns and likes to learn. Style characteristics reflect genetic coding, personality development, motivation, and environmental adaptation. Style is relatively persistent. . . It can change, but does so gradually and developmentally" (p.2).

According to Dunn and Griggs (1988), "Learning style is a biologically and developmentally imposed set of characteristics that make the same teaching method wonderful for some and terrible for others" (p.3).

Rita and Kenneth Dunn have described learning style as "The manner in which at least 18 different elements of four basic stimuli affect a person's

ability to absorb and to retain information, values, facts or concepts" (Guild & Garger, 1985, p. 44). Dunn and Dunn's comprehensive definition includes the following stimuli categories: environmental (sound, light, temperature, design); emotional (motivation, persistence, responsibility, structure); sociological (peers, self, pair, team, adult, varied); physical (perceptual, intake, time, mobility) (Guild & Garger, 1985).

David Kolb suggested that a learning style is the combination of how we perceive and how we process information. He professed that a learning style is unique and reflects our most comfortable way to learn (McCarthy, 1981).

Bernice McCarthy's (1981) concept and definition of learning style was influenced by David Kolb's research work. She too concluded that learning styles are unique and reflect the fact that people learn differently. Her definition of learning styles included not only how one perceives and processes information but also how one senses, feels, and experiences the learning process. McCarthy noted, "Learning styles are characteristic penchants for perceiving and processing information and experience that are unique to individuals and developmental through life stages. They are comprised of complex

interactions of physiological, psychological, environmental and situational variables" (p.86).

According to Armin Theis (1979), "Those conditions that maximize a student's performance define that person's 'learning style'" (p. 55).

Ronald Schmeck (1988) stated that styles and motives relate to genetics and prior experiences which cannot be directly observed. Schmeck submitted that learning styles are composed of observable behavioral patterns which have been influenced by preferential styles, motives, personal experiences, and interactions encountered in the learning situation.

Anthony Gregorc (1979) from an analysis of what people said and did, developed the following phenomenological definition: "Learning style consists of distinctive behaviors which serve as indicators of how a person learns from and adapts to his environment. It also gives clues as to how a person's mind operates" (p. 234). Gregorc (1979) concluded that learning styles are inborn and individuals have natural predispositions or proclivities toward a given style. Gregorc fostered the view that learning styles are distinctive and observable behaviors which suggest to others how individuals relate to the world and therefore, how they learn. He proposed that these behaviors and preferences are what allow for the

identification of learning styles through either observation, interviews, or self-reporting.

Multi-Sensory Approach

Maria Montessori is credited with pioneering the multi-sensory approach to education (Gross, 1978). She developed what is known today as "The Montessori Method". This method stresses the use of didactic materials integrating kinesthetic-tactual learning experiences with auditory and visual sensory modalities. Montessori emphasized that educators must teach children to work with their hands as well as their minds. She suggested that there is a natural process [a preferential learning style] by which a child's personality develops. Once identified by the teacher, this natural learning process is utilized to influence the harmonious growth of all the potentialities of each child (Gross, 1978). By providing an enriched learning environment and keenly observing the child's behavior, Montessori declared that the child's choices will lead the teacher to the identification of learning activities which are naturally best suited for that particular child (Gross, 1978).

Barbe and Swassing (1979) noted that during the 1960's, modality based instruction became strongly

associated with the special education movement. They credit Samuel Kirk as the first educator to popularize the term intraindividual differences and to describe the variations in learning strengths evident in each individual child. Kirk popularized the concept of individual diagnosis and prescriptive remediation which is widely accepted in special education. This approach involves the identification of an individual student's perceptional strengths and deficiencies. Multi-sensory instructional methodology is then utilized to remediate specific learning disabilities. It is this very close identification with special education, according to Barbe and Swassing (1979), which has hindered widespread acceptance of modality based instruction within the traditional mainstream classrooms.

C. N. Kephart's (1965) interest in modality-based education expanded beyond the realm of special education and learning disabilities. Kephart suggested that the traditional learning environment was too restrictive and structured, inhibiting sensory and motor manipulations. He echoed Montessori's concept that kinesthetic-tactual learning activities are basic to the development of academic skills. Kephart felt strongly that all students, not just those with learning disabilities, should be exposed to a learning environment which fosters multi-sensory interaction,

capitalizing on the senses of movement and touch (Barbe & Swassing, 1979).

It is unfortunate that the history of modality-based instruction has been so closely associated with special education and remediation of slow learners. As a result, its potential utilization in the regular instructional program has been largely underestimated (Lehr, 1988; Barbe & Swassing, 1979).

Recent Recognition

Two separate issues were the catalysts for generating recent interest in teaching/learning styles. First, the 1970's were characterized by mounting public concern for educational accountability (Dunn & Dunn, 1978). In addition, court decisions and legislative actions were prompting the school system to more effectively educate those types of students who had historically demonstrated inadequate academic achievement (Dunn & Griggs, 1988). Second, research related to split-brain hemispheric dominance surfaced which suggested educational implications for learning styles. Interested educators began to investigate the plausibility of utilizing concepts of teaching/learning styles as an avenue for reaching the underachieving students (Blakeslee, 1980; Buzan, 1946; Durden-Smith &

deSimone, 1983; Hirsch, 1985; Hunter, 1976; Restak, 1979; Rubenzer, 1985; Sanders & Sanders, 1984; Shuttleworth, 1987; Springer & Deutsch, 1981; Vitale-Meister, 1982).

Assessment and Classification

The purpose of assessment and identification of learning styles is to provide students and teachers, as well as parents, with information which will assist all of them in the realization of the student's full potential (Gregorc, 1977, 1979; Guild & Garger, 1985; McKeachie, 1988). Learning style assessment is regarded as one of the essential factors to cultivating an understanding of student learning (Griggs, 1988; Mayer, 1988). James Keefe (1979) noted, "An understanding of the way students learn is the door to educational improvement. And learning style [assessment] diagnosis is the key to understanding" (p. 124).

A number of assessment instruments have been developed and are available. They vary in design and scope (Guild & Garger, 1985; McCarthy, 1981; Rubenzer, 1985; Schmeck, 1988). Learning styles can be identified through observation, interviews, and paper-pencil instrumentation (Gregorc, 1979). However,

self-reporting is the principal methodology utilized (Gregorc, 1979; Sewall, 1986; Weinstein, 1988). The method of self-reporting requires the individual to identify and/or prioritize personal preferences. The scope of the assessment instrument varies according to the developer's definition of learning style. The design of learning style assessment instruments appear to be more closely grounded to the research methodology of the qualitative, rather than quantitative paradigm.

Barbe and Swassing's (1979) interest in assessment focused on the identification of modality strengths. They subscribed to a broad definition of modality that comprises sensation, perception, and memory. Barbe and Swassing professed that the auditory, visual, and kinesthetic-tactual modalities are the most important sensory channels for education (Guild & Garger, 1985).

Their assessment instrument, the Swassing and Barbe Modality Index (SBMI) (1979), tests modalities, (auditory, visual, kinesthetic-tactual), and classifies them as dominant, secondary, or mixed modality strength. This identification then serves as the framework from which a modality-based instructional program is designed. The intent is to capitalize on the student's modality strength(s) in order to more effectively accomplish the primary goal of education.

Application of the SBMI has encouraged teachers in mainstream education classes to incorporate modality-based instruction into the learning environment for all students.

Lynn O'Brien (1985), founder and president of Specific Diagnostic Studies, developed a simplistic self-reporting instrument designed to assess modality preference. This check-list style instrument provides a quick inventory of preferences for the modality categories of auditory, visual, and haptic.

The Learning and Study Strategies Inventory (LSSI), developed by Weinstein, Schulte, and Cascallar (Weinstein, 1988), identifies differences in preferred learning strategies and how that may directly affect learning outcomes and academic achievement. This instrument was designed to assist teachers in providing a more meaningful set of preferred learning strategies best suited to individual student's preferential learning style. The LSSI was developed primarily for use at the college level (Weinstein, 1988).

The Embedded Figures Test (EFT) (Browne, 1986) was originally designed by Herman A. Witkin to assess differences in perceptual style. The EFT requires subjects to identify simple to complex figures which have been embedded into different field designs. Field-independent and field-dependent form the ends of

a continuum between which an individual's scores are placed and evaluated. After extensive usage, Witkin concluded that the EFT was assessing intellectual style as well as perceptual style.

Witkin determined that field-independent mode of perceiving/thinking is rapid, discrete, and articulate. The field-independent subject is able to dissemble and reorganize alternate organizational patterns. The field-dependent is less accurate, slower, and dominated by the organizational surroundings in which details and parts tend to fuse. In learning situations, the field-dependent subject views content in a global manner and has difficulty distinguishing parts separately from the whole. Witkin's assessment instrument has been used to evaluate student learning style preference for left hemisphere (field-independent) and right hemisphere (field-dependent) processing (Browne, 1986).

Rosalie Cohen (Browne, 1986) identified two mutually incompatible styles which she labeled analytic and relational. The analytic style is formal, analytical, reality bound, and field-independent. These are characteristics associated with left hemisphere processing. The relational style represents a self-centered field-dependent, global orientation to reality. This style is associated with right

hemisphere processing which establishes meaning only in reference to some total context (Browne, 1986).

Cohen's work synthesized the results of considerable research. She concluded that the analytic style (left brain hemispheric processing) predominants the school system. She proposed that cultural conflicts exist in the school system because minority groups demonstrate a preference for the relational (right brain hemispheric processing) learning style which is totally incompatible with the analytical style (left brain hemispheric processing) (Browne, 1986).

Psychologist Carl Jung is credited with identifying and classifying four basic psychological types. These four types are known as: feelers, thinkers, sensors, and intuitors. The descriptors he applied to each category of the four psychological types have greatly influenced learning style researchers such as David Kolb, Anthony Gregorc, Alexis Lotas, Barbara Bree Fisher and Louis Fisher, and Katherine Briggs and Isabel Briggs Myers in their various classifications of learning styles (Guild & Garger, 1985; McCarthy, 1981).

Applying the theories of Carl Jung, Katherine Briggs and her daughter, Isabel Briggs Myers, developed the Myers-Briggs Type Indicator (MBTI) (Guild & Garger, 1985) designed to assess personality types. This

instrument uses forced-choice questions and word pairs to evaluate factors such as: intuition versus sensation; thinking versus feeling; extraversion versus introversion; judging versus percepting. The MBTI has been used extensively by human resource professionals such as psychologists and counselors in order to permit individuals to learn about their own personality types (Guild & Garger, 1985). Most recently, the MBTI has been used in educational settings for the identification and practical application of learning styles theories by educators in the classroom (Lawrence, 1982).

David Kolb developed the Kolb Learning Style Inventory (KLSI) ((McCarthy, 1981). His inventory instrument is based on a bi-dimensional model which polarizes the paired dimensions of concrete experiences (sensing/feeling) to abstract conceptualization (thinking) and active experimentation (acting) to reflective observation (watching). Depending upon one's responses on Kolb's self-reporting instrument, an individual will be classified as one of four possible learning style types: diverger (concrete experience and reflective observation); assimilator (abstract conceptualization and reflective observation); converger (abstract conceptualization and active

experimentation); or accommodator (concrete experience and active experimentation) (McCarthy, 1981).

The KLSI is one of several instruments frequently cited as a tool of choice in research projects. It has also served as the basis for practical classroom curricular applications of learning style concepts (McCarthy, 1981).

Alex Lotas, a field practitioner and high school principal, developed the Lotas Teaching Performance Questionnaire (LTPQ). This instrument measures teaching styles and their congruency to learning style classifications which are based upon Carl Jung's four personality classifications (feelers, thinkers, sensors, intuitors). Lotas' learning style classifications include: affective one learner (learns best with others, highly sensitive), affective two learner (uses facts, abstract thinker); cognitive one learner (dominated by practical concerns based on accurate information); and cognitive two learner (concerned with meaning of life and purpose based on moral and aesthetic considerations) (McCarthy, 1981).

College professors, Barbara Bree Fisher and Louis Fisher have conducted learning style research. Their work also appears to be grounded in Jung's four basic psychological types. They have identified and

classified the following learning styles: emotionally involved (prefers colorful, vivid learning environment with dynamic interplay of ideas and activities); incremental (prefers sequential presentations, systematically adding pieces together to gain understanding); sensory generalist/specialist (utilizes all sensory modalities together to gather and test information/primarily relies on one dominant sense, usually sight or sound); and intuitive (makes leaps and demonstrates insights upon which to form accurate generalization derived from systematic gathering of information and experience) (McCarthy, 1981).

The Learning and Study Strategies Inventory (LSSI) was developed by Claire E. Weinstein (1988) to be used primarily with college age students. This self-reporting instrument stresses the identification of learning differences which seem to directly affect learning outcome and academic achievement.

Rita and Kenneth Dunn have been frequently cited in the literature and are perhaps among the best-known researchers of learning styles (Guild & Garger, 1985). Rita and Kenneth Dunn, in collaboration with Gary Price (1979), developed a self-reporting instrument called, The Learning Style Inventory (LSI) (Dunn, Dunn, & Price, 1979). The LSI is available in two different forms geared for grades 3-5 and 6-12, respectfully. A

third version, the Productivity Environmental Preference Survey (PEPS) is designed for adults.

The LSI assesses up to 18 different elements which Rita and Kenneth Dunn have identified as components of a learning style. The LSI inventories and evaluates elements in four basic stimuli areas: environmental (sound, light, temperature, physical design); emotional (motivation, persistence, responsibility, structure, flexibility); sociological (works best alone, in pairs, with peers or adults); physical (perceptional strengths, intake, time, mobility) (Browne, 1986). A computer scored profile is produced which is used to counsel and assist student and teacher in the understanding and positive utilization of one's individual learning style within the educational environment. The LSI is frequently cited in the literature. It has had widespread and varied application in research projects particularly at St. John's University, New York, where Rita Dunn is a professor of education (McCarthy, 1981).

The National Association of Secondary School Principals (NASSP) Learning Style Profile (LSP) developed by J. W. Keefe provides a comprehensive evaluation of learning style. It attempts to diagnose dimensions of cognitive, affective, and physiological/environmental styles. It provides

profiles in 24 independent subscales representing four higher order factors, eight cognitive styles, three perceptual responses, and 13 study or instructional preferences (Keefe, 1988).

Anthony Gregorc, Professor of Curriculum and Instruction at the University of Connecticut is well known for his research on learning styles (McCarthy, 1981). He developed the Gregorc Model which describes an individual's cognitive learning style in terms of preferred ways of learning (Gregorc 1977; Keefe, 1987).

The Gregorc's Style Delineator (GSD) (Gregorc, 1977) was designed by Anthony Gregorc to assess cognitive learning styles. The GSD employs two sets of dualities which serve as opposite ends of their respective continuums. The first duality suggests a preference for the use of concrete or abstract perceptions. The second duality determines preferences for ordering of thought processes in terms of sequential (linear) or random (non-linear) processing (Gregorc, 1977; Guild & Garger, 1985; McCarthy, 1981). Both sets of dualities, for perception and ordering, are combined to form a matrix-grid representing Gregorc's four distinct patterns of learning styles. These styles are: abstract-sequential, abstract-random, concrete-sequential and concrete-random. Individual scores are plotted on the matrix-grid which in turn

indicates one's preferential learning style. The GSD is designed primarily for use with adults (Gregorc, 1977).

Evaluation of Assessment Instruments

The vast majority of assessment instruments cited in the literature are self-analysis or self-reporting in design. The design of most learning style assessment instruments, with the exception of Keefe's LSP (1988), appear to be more closely grounded to the qualitative research paradigm than that of the quantitative (Agar, 1980; Gregorc, 1977; Keefe, 1988; Weinstein, 1988; Yin, 1984).

Timothy Sewell's (1986) critical evaluation of self-reporting assessment instruments appears to be based upon standards typically associated with traditional quantitative research methodologies. Sewall reviewed different self-reporting instruments, including the Myers-Briggs' Type Indicator, Kolb's Learning Style Inventory, and the Gregorc's Style Delineator. He indicated concern over the lack of comparative norms and documentation verifying reliability and validity. Sewall was highly critical of self-reporting assessment instruments. He found them to be poorly designed instruments which could

generate weak or misleading data. He questioned whether or not the assessment instruments currently available were of sufficient psychometric quality to warrant their continued use either for research or educational purposes.

Thomas Blakemore (1984) reviewed several learning style assessment instruments including Dunn's Learning Style Inventory and Kolb's Learning Style Inventory. He found a great diversity in their content and scope. Blakemore expressed concern that there was very little information available on any of the instruments relating to the issues of reliability and validity. He noted that in fairness to the developers most of the instruments were relatively new and it would take time to collect data necessary to support reliability and validity. Blakemore strongly suggested a critical evaluation, even field testing, before extensively utilizing these assessment instruments.

Blakemore, like Sewell (1986) grounded his evaluation of self-reporting instruments to methodology standards traditionally associated with the quantitative research paradigm. Neither Sewell nor Blakemore considered the paradigm frame of qualitative methodology in their evaluations.

Anthony Gregorc's research methodology on learning styles is grounded to qualitative research methodology

(Gregorc, 1979). He formulated a phenomenological definition of learning style based upon qualitative methods including observations, interviews, and self-analysis. The Gregorc Style Delineator (GSD) (1977) is therefore a self-reporting instrument.

With regard to assessment and diagnosis of learning styles, Anthony Gregorc noted:

> We must bear in mind . . . that any idea that has the potential for doing serious human good, also has the potential for doing serious harm. This must be kept in mind particularly when using the many fine learning/teaching style assessment instruments available (Gregorc, 1979, p.234).

Gregorc (1979) alerted those who may choose to utilize a self-reporting assessment of the following obstacles which might impede an accurate assessment and diagnosis of learning styles: (a) instruments tend to be exclusive in focus and not all variables may be considered; (b) some students may choose not to respond honestly to the self-reporting questions; (c) students who may have adopted an artificial style, may report these behaviors and thus receive prescriptions that continue to reinforce the artificial style rather than the natural abilities; (d) educator/administrator bias toward the student and/or the concept of diagnosis/

prescription may influence instrument interpretation and prescription. Gregorc concluded, "Diagnosis of learning style is far from being an exact science. We must however, continue to diagnose in order to understand more about the human mind and how people learn" (Gregorc, 1979, p.236).

Dauna Browne (1986) examined instruments developed to assess cognitive learning styles. She reviewed six different instruments including Dunn's Learning Style Inventory and Gregorc's Style Delineator. In reference to self-reporting instruments she cautioned, "The accuracy of the classification of learning style depends in part on how objective a person is able to be about personal feeling" (Brown, 1986 p.4).

Claire E. Weinstein (1988) attempted to bridge the two research paradigms by evaluating her own self-reporting assessment instrument (LSSI) utilizing quantitative methods, such as test-retest coefficient of reliability and concurrent correlation coefficient to a similar test, to demonstrate reliability and validity. She found that quantitative evaluation alone does not affectively apply to self-reporting instrumentation. Qualitative methods such as self-analysis, follow-up interviews, and observations of practice over time need also to be employed in the establishment of reliability and validity. She

concluded self-reporting instruments were valid assessment instruments and reliability and validity could be established through a combination of quantitative and qualitative methods such as interviews, test-retest procedures, demonstration through field practice over time, and establishment of construct validity.

Gender

While everyone is capable of conceptualizing and organizing information, individuals tend to rely more on either the left or right hemisphere while processing information. Some researchers have suggested that gender may play a significant role in predispositioning an individual reliance on left or right hemispheric processing (Blakeslee, 1980; Durden-Smith & deSimone, 1983; Restak, 1979).

Females appear to process words more in terms of abstractions, a left brain processing function. Females also seem to use the left brain for both visual-spatial processing as well as for verbal tasks. Males, on the other hand, process word meanings more through concrete connections as well as abstractions. Blakeslee (1980) noted that males, generally speaking, seem to have a greater propensity for using both

hemispheres of the brain for global, holistic, processing, thereby demonstrating a less lateralized brain organization than females.

The differences between male and female brain organization may be inborn or the result of hormonal programming (Durden-Smith & deSimone, 1983; Restak, 1979). Even as infants, males have been found to have greater visual-spatial (right brain) ability, while females have greater verbal ability (left brain). Males are superior to females in visual acuity and respond more readily than females to their environment. Females excel at fine motor tasks while males do better in tasks requiring gross body movement requiring fast reaction time (Durden-Smith & deSimone, 1983; Performance Learning Systems, 1983; Restak, 1979).

Gender may also affect learning style behavioral characteristics such as motivation and task persistence. Smey-Richman (1988) discussed research studies which suggested that girls tend to have unduly low expectancies, tend to avoid challenge, to focus on ability attributions for failure, and to exhibit debilitation under failure. According to Smey-Richman, one study compared boys and girls with high grade point averages and found "that girls much preferred tasks at which they could succeed, where as boys preferred tasks at which they would have to work hard to master"

(Smey-Richman, 1988, p. 13). It was concluded that boys are more likely to prefer academic areas such as mathematics, which necessitates surmounting difficulties at the beginning of units. Girls it was suggested, demonstrate a more learned helplessness orientation in mathematics and science than do boys (Smey-Richman 1988).

It is not clear the extent to which gender acculturation may influence learning style behavioral characteristics such as motivation and persistence. Societal expectations, tolerances and intolerances, for gender behavior are clearly established. Therefore it is difficult to determine what are inherent and what are conditioned behaviors (Gilligan, 1982; Rossi, 1985).

Ethnicity

Some research has been conducted on ethnicity and preferential learning styles which suggests that there may be cultural biases for cognitive style. Native Americans, Hispanics, and Blacks seem to adhere to learning styles which are incongruent with traditional teaching styles and thus may find themselves disadvantaged in the traditional educational process. Anglos and Asians, on the other hand, seem to

demonstrate learning style preferences which are congruent with the traditional teaching styles (Browne, 1986; Performance Learning Systems, 1983; Smey-Richman, 1988).

According to Browne's research (1986), "many, but certainly not all, Native American children will probably demonstrate right hemispheric dominant learning styles" (Browne, 1986, p.13). Browne suggested that these Native Americans are disadvantaged in the left brained dominant educational system. She noted, "I'd be willing to bet that your left hemisphere learners are your better achievers. And the behaviors that I have called right hemisphere dominant are ones you have associated with poor achievers" (Browne, 1986, p. 13). She concluded that Native American children should be taught language and reading skills by using a holistic (right hemispheric) approach which also recognized Native American language, culture, and learning styles.

Smey-Richman (1988) stated that there are perceptual, cognitive, and behavioral differences among racial and ethnic groups that contribute to low achievement in minority students. She cited various studies which suggested that Black and Hispanic students demonstrate field-dependent (right hemisphere) learning style preferences, whereas white students

demonstrate field-independent (left hemisphere) learning style preferences. She noted that Blacks appear to process information differently than Whites. Blacks "prefer intuitive rather than inductive or deductive reasoning and approximate rather than exact concepts of space, number, and time, as well as relying on nonverbal communication more than others" (Smey-Richman, 1988, p.15). A possible cultural explanation for these differences may be that Black children are taught to concentrate on many, varied stimuli at one time rather than learning to concentrate on only one. White students, on the other hand, are socialized to tolerate monotony or unvaried presentation of material (Smey-Richman, 1988).

Hispanic students, generally speaking, tend to be field-dependent (right hemisphere) processors which may place them at academic risk within the traditional educational environment. Hispanic students prefer cooperative rather than competitive learning situations involving nonanalytical tasks (Browne, 1986; Performance Learning Systems, 1983). Research has also shown that some Hispanic subgroups ("Chicanos") are also alienated from the traditional school culture and have rejected the behavioral and formative patterns required for scholastic achievement (Smey-Richman, 1988).

Generally speaking, Asians as well as Whites, demonstrate left hemisphere learning style preferences. Both Whites and Asians prefer a competitive learning environment to a cooperative learning setting (Smey-Richman, 1988).

Asians have demonstrated amazing educational success in the traditional school system (Smey-Richman, 1988). Observable cultural values, such as restraint and patience, are crucial elements which result in a precise and accurate learning style especially in spatial and numerical reasoning and less well to verbal learning (Performance Learning Systems, 1983).

Applied Research Efforts

Beginning in the mid 1970's and continuing through the 1980's, some educators in the field have attempted to respond to the concepts of teaching and learning styles by identifying individual learning preferences and adjusting instructional programs accordingly (Butler, 1985; Dunn & Bruno, 1985; Dunn & Dunn, 1979; Dunn & Griggs, 1988; Edwards, 1979; Gregorc, 1979; Hunter, 1976; Lemmon, 1985; McCarthy, 1980; Rubenzer, 1985; Sanders, 1984; Schmeck, 1988; Vitale-Meister, 1982).

Shirley Griggs (1988) reviewed twenty-six research projects on learning styles in the areas of teaching, learning, and counseling. She noted that applied research was an important way for educators to evidence accountability and justification for classroom implementation of learning styles. This expanding core of research was important, according to Griggs, because it clearly demonstrated the need for teachers to accommodate for individual student learning preferences within the educational process.

Corinne Cody (1983) conducted a study using the Learning Style Inventory (LSI) (Dunn, Dunn, & Price, 1979) which verified the fact that average, gifted, and highly gifted students have patterns of learning styles that are significantly differentiated. For example, average students preferred quiet, warmth, late day, and structure. They had less motivation and indicated more integrated and left brain processing. Gifted students preferred quiet, moderate temperature, and less structure. They had more motivation, and indicated more integrated and right hemisphere processing. The highly gifted preferred sound in the learning environment, cooler temperatures, evening, and the least amount of structure. They had the highest motivation and indicated more integrated and right brain processing. Left dominant students preferred

more formal design, more structure and less intake. Right dominant students disliked structure and were not adult motivated. She concluded that differences in learning preferences should be taken into consideration in structuring the teaching and learning process.

P.K. Lynch's (1981) research dealt with the learning style factor of time preference. Utilizing the LSI (Dunn, Dunn, & Price, 1979), he investigated the relationships among academic achievement, attendance, and learning style time preferences. Lynch determined that the greatest single influence on the reduction of truancy among chronic truants was matching the students' learning style time preference for instruction. The time element of an individual's preferential learning style was found to be the most important factor in the reduction of truancy (Lynch, 1981).

Paul Trautman (1979) studied the relationship between selected instructional techniques and identified cognitive style, (analytic or global). Using the LSI (Dunn, Dunn, & Price, 1979), he determined that student achievement in knowledge, comprehension, and application was significantly greater when instructional method was congruent with the student's diagnosed cognitive style.

Ralph Angelo (1983) noted that there needs to be

variation in the instructional presentation. He suggested that there were strong implications for instructional and curriculum designs to include variation for differing cognitive style preferences.

Regina White (1981) examined the relationship between instructional methods, emotional learning style, and student achievement. The LSI (Dunn, Dunn, & Price, 1979) was employed. She determined that students identified as more persistent and responsible manifested conforming behavioral styles and maintained higher levels of achievement. She speculated that less persistent and responsible students are not as conforming in behavior and therefore demonstrated lower levels of achievement. She concluded that the learning environment should offer choices for the non-conforming students and that allowing choices was an effective way of accommodating for their differing learning styles. She suggested that alternative methods of instruction should be a regular part of the instructional process.

Douglas K. Smith and Peter J. Holliday (1986) considered differences in learning style and academic achievement in fourth, fifth, and sixth grade students. The LSI (Dunn, Dunn, & Price, 1979) was used to identify sociological, emotional, environmental, and physiological factors. The Iowa Test of Basic Skills was used as a basis for grouping achievement scores.

They determined that students do in fact manifest significant variations in how they prefer to learn. High and low achievers displayed a significant preference for a particular learning style, while average achievers did not. High achievers proved to be more independent and motivated than the others. Smith and Holliday concluded that teaching strategies could be developed to enhance learning of all the different achievement groups.

David H. Kalskeek's (1986) research project involved tracking retention levels and academic integration of college students by learning style. He employed the Myers-Briggs Type Indicator (MBTI). Kalskeek found that certain MBTI learning styles were disproportionately represented in specifically identified academic areas. For example, the most abstract and reflective learning style was most common in the art and science majors. Students with the most concrete and active learning style scored the lowest on aptitude measures. The greater the student's preference toward the judging mode, the better their grade point average. Kalskeek concluded that the use of the MBTI indicators could enable assessment of both measures of social and academic integration as well as the cognitive and affective processes that influence this integration.

Patricia S. Bowers (1987) investigated the effects of Bernice McCarthy's 4MAT instructional system on achievement and attitude among gifted sixth grade students. She employed an experimental design where the 4MAT instructional variables were employed only with the experimental group. Her results were mixed. She found significant differences favoring the 4MAT group for overall achievement and on critical thinking questions, and when analyzing unit specific statements. No significant differences were found on knowledge-level questions. Significant differences favoring the restricted-textbook control group were found when analyzing statements about science in general. Bowers concluded that there was merit in using the 4MAT instructional system approach for school utilization and research as well. She concluded that the 4MAT instructional system holds promise to meet the challenge of curricular reform in education.

Candace Wheeler (1988) considered the question of whether or not there was any correlation between the learning styles of remedial students and computer-assisted instruction. She determined that all subjects had a strong to moderate kinesthetic preference and most had high visual strengths. Her research supports the following conclusions: (a) the ability to manipulate computer formats facilitates learning;

(b) low achievers have similar learning characteristics categorized as kinesthetic/visual learning style; (c) when the style of kinesthetic/visual is matched and accommodated the achievement level of the student is increased; (d) holistically designed, global (right hemisphere) problem-solving software format affects positive reading performance among low achievers.

Dauna Browne (1986) conducted a study in which she applied the concepts of cognitive style and brain hemisphere preference to Native American children. She concluded that Native American children exhibit learning behaviors patterns characteristic of right hemisphere processing. Building on the research of Herman A. Witkin (Browne, 1986) and Rosalie Cohen (Browne, 1986), Browne reasoned that there was a strong connection between learning style and level of achievement in school. She speculated that many Native American children who demonstrate right hemisphere dominant learning styles do not experience high levels of academic achievement because they are expected to operate in a predominantly left hemisphere oriented learning environment. She concluded that holistic (right hemispheric) instructional methodologies should be utilized in order to more effective teach language arts skills to Native American students.

Practical Implementation

The literature abounds with references documenting practical implementations of learning style theories and concepts. For discussion purposes, implementation efforts have been clustered into four categories: (a) identification, assessment, and diagnosis; (b) adaptations of instructional methodology; (c) curricula reforms; (d) staff development efforts.

Identification, Assessment, and Diagnosis

The history of education has witnessed many trends which have briefly impacted the course of the profession. But, due to the research efforts of individuals such as Barbe and Swassing, Witkins, Cohen, Myers and Briggs, Kolb, Dunn and Dunn, Keefe, Gregorc, and others learning style theories and concepts have been legitimized (Barbe & Swassing, 1979; Browne, 1986; Gregorc, 1977, 1979; Guild & Garger, 1985; Keefe, 1989; McCarthy, 1981). They are no longer viewed as just another trend soon to be fast fading. Rather, learning styles are seen today to have meaningful and practical application (Anderson & Bruce, 1979).

The identification of different learning styles has prompted educators to recognize and deal with the proven fact that not all students learn in the same

manner. Identification of preferential learning styles has also made it possible for educators to develop and offer more appropriate learning activities for all students. An accurate assessment of differing learning styles and the description of characteristics specific to each style paved the way for diagnosis. Subsequently, diagnosis has been used to provide counseling aimed at self-help and improved academic achievement (Barbe & Swassing, 1979; Claxton, 1988; Dunn & Dunn, 1979; Dunn, Dunn & Price, 1979; Dunn & Griggs, 1988; Gregorc, 1979; Guild & Garger, 1985; Hirsch, 1985; Keefe, 1987, 1989; McCarthy, 1981; Restak, 1979; Vitale-Meister, 1982).

Adaptations of Instructional Methodology

The instructional methodology of the traditional school system favors teaching styles which are auditory/visual, sequential, analytic, and left hemisphere process oriented in their presentation (Hunter, 1979; Hirsch, 1985; Rubenzer, 1985; Vitale-Meister, 1982). Students whose preferential learning styles are kinesthetic/visual, non-linear, global, relational, and right hemisphere process oriented are continuously expected to function in a learning environment where teaching/learning styles are in disharmony (Butler, 1985; Gregorc, 1979; Hirsch,

1985; Hunter, 1976; Vitale-Meister, 1982). Some students are fortunate to be able to have adaptive abilities to match their learning style with the teaching style at hand. Unfortunately, a large number of students remain who appear to lack this ability (Gregorc, 1979).

Charles A. Letteri (1989) declared, "Learning problems are frequently not related to the difficulty of the subject matter, but rather to the type and level of cognitive processes [learning style] required to [sic] learning the materials" (p. 22). It has been alleged that when teaching/learning styles are not in alignment, the learner becomes frustrated and effective learning does not take place (Barbe and Swassing, 1979; Butler, 1985; Dunn & Dunn, 1979; Guild & Garger, 1985; Gregorc, 1979; Hirsch, 1985; Hunter, 1976; Vitale-Meister, 1982).

Theories of teaching styles have paralleled those of learning styles (Herbster, 1987). It has been documented that teachers tend to teach in a style that is reflective of their own personally preferred learning style (Barbe & Swassing, 1980; Butler, 1985; Dunn & Dunn, 1979; Gregorc, 1979; Haring, 1985; Hunter, 1976; Kirk & O'Neil, 1988; Performance Learning Systems, 1982; Vitale-Meister, 1982).

Kathleen Butler (1985), building on the Gregorc Model (Gregorc, 1977, 1979) of learning styles, identified and described specific behavioral characteristics of four distinctively different teaching styles. These four teaching styles, (abstract-sequential, abstract-random, concrete-sequential, and concrete-random), are congruent with the learning styles identified by the same names and described by Anthony Gregorc (1977, 1979). Butler's work demonstrated that it is possible to effectively match teaching styles to corresponding learning styles.

It has been advocated that the best learning environment for a student is one in which teaching/learning styles are congruent (Barbe-Swassing, 1979; Butler, 1985; Dunn & Dunn, 1979; Gregorc, 1979; Hunter, 1976; Keefe, 1989; Performance Learning Systems, 1982; Vitale-Meister, 1982). It has been suggested that the teacher must assume the responsibility for altering the instructional methodology in order to achieve harmony and alignment between teaching/learning styles. The logical extension of this alignment theory would be to so democratize the educational process that all students, regardless of their preferential learning style, would receive a more effective education. The implication is that matching teaching/learning styles will not only improve the learning experience but will

also result in improved levels of academic achievement (Barbe-Swassing, 1979; Butler, 1985; Dunn & Bruno, 1985; Gregorc, 1979; Hunter, 1976; Keefe, 1989; Lehr & Harris, 1988; McCarthy, 1981; Performance Learning Systems, 1982; Rubenzer, 1985; Vitale-Meister, 1982).

Curricular Reform

The concept of matching teaching/learning styles seemed to hold promise for the improvement of the quality of education for many learners but some educators raised concern that diagnostic/prescriptive instruction was not practical in most classroom situations (Hilgersom-Volk, 1987). Practical implementation on a large scale would require curricular reform which would prompt teachers to utilize a variety of teaching styles in their instructional programs (Guild & Garger, 1985; Hunter, 1976; McCarthy, 1980).

Madeline Hunter (1976) was one of the first to suggest that more students could be effectively taught if instructional methodologies and learning activities were constructed and beamed to right hemisphere processors. She also encouraged teachers not to exclusively rely on any single instructional modality.

Instead, she advocated that information be presented in a balanced manner equally utilizing auditory, visual, and kinesthetic-tactual modalities. Hunter professed that by maintaining a balance in instructional methodology, the school system could overcome its heavy reliance on left hemisphere teaching styles and thereby free the right brain learners who find themselves trapped in a left brain dominant educational environment.

Bernice McCarthy (1981) contributed to curricular reform through the development of the 4MAT System. She identified and described the learning behaviors of four different learnings styles: innovative, analytic, common sense, and dynamic. The 4MAT System involves consistently rotating the presentation of curricular material through instructional presentations beamed at the distinctive learning behaviors for each of the four specific learning styles. The 4MAT System assures that all students will receive instruction in their preferential learning style at least 25% of the time. The 4MAT System has served as a guide for the development of curricular guides and successful classroom implementations have been documented using the 4MAT System (Arnold, 1987; Bowers, 1987).

Individual learning style preferences may also be accommodated by developing a variety of learning

activities appropriate to given styles and then allowing students to choose which activities they prefer to engage (Butler, 1985; Davidman, 1984; McCarthy, 1981; White, 1981). Kathleen Butler's (1985) work provided a format outlining specific learning activities best suited to the four given learning styles (abstract-sequential, concrete-sequential, abstract-random, concrete-random) originally identified by Anthony Gregorc (1979). Students will naturally tend to select activities which are congruent with their preferential learning style (Gross, 1978). Exclusive matching of styles is not desirable and this may be avoided by limiting choices or by rotating teaching styles so that students are routinely exposed to different types of learning styles and activities (McCarthy, 1985).

Although the principal thrust of curricular reform has centered on the individual classroom, some effort has been made to implement learning style concepts on a school-wide basis (Cohen, 1987). In addition, the current format for textbooks is also being evaluated. It has been suggested that textbooks are needed which will accommodate differences in learning styles and provide congruent learning activities (Edwards, 1979; Macian & Harewook, 1984; Weaver, 1986). Computer-

assisted instruction also has been suggested as an alternative method for addressing differences in learning styles (Clariana & Smith, 1988).

Teacher Training and Staff Development

Teacher training and staff development programs are key factors for successful implementation. Those who teach need to have a working knowledge and understanding of the concepts of teaching/learning styles. They need to be aware of their own learning style and how it impacts their teaching style. They must be able to recognize behavioral characteristics which are typical of different student learning styles. Teachers must also be able to recognize different teaching styles and be capable of appropriate utilization of them (Barbe & Swassing, 1980; Butler, 1985; Claxton, 1988; Davidman, 1984; Dunn & Dunn, 1979; Gregorc, 1979; Haring, 1985; Hilgersom-Volk, 1987; McCarthy, 1981; Performance Learning Systems, 1983).

Summary

Learning styles do in fact exist. They can be identified and diagnosed. Learning style preferences represent individual learning difference among students. The dynamics of learning styles constitute a viable teaching paradigm (Claxton, 1988; Hilgersom-Volk, 1987; Guild & Garger, 1985; Lembke, 1985; Thompson, 1986). Matching teaching/learning styles can be realized on an individual as well as a classroom basis (Barbe & Swassing, 1980; Butler, 1985; Dunn & Dunn, 1978; Edwards, 1979; Hunter, 1976; McCarthy, 1981; Vital-Meister, 1982). Alignment of teaching/learning styles can facilitate more positive learning experiences and in some instances may improve levels of academic achievement as well (Angelo, 1983; Arnold, 1987; Bowers, 1982; Browne, 1986; Claxton, 1987; Davidman, 1984; Lembke, 1985; Lynch, 1981; Smith & Holliday, 1986; Trautman, 1979; Wheeler, 1988; White, 1981).

The American ideal to provide an equal educational opportunity for all remains the same. Schools exist for all students (Jenkins, 1989). The National Association of Secondary School Principals (1989) suggests that learning style is a concept which generates equal access to the curriculum and promotes a

school climate for positive student achievement because it recognizes that all students are not the same, and that they do not learn the same way (NASSP, 1989). One way to help more students achieve in our schools would seem to involve offering them different ways to successfully accomplish common learning objectives (Jenkins, 1989). Implementing concepts of teaching/ learning styles can certainly open the door to academic improvement for all learners (Keefe, 1979).

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

Study Objectives

Researchers have suggested that awareness and utilization of students' preferential learning styles positively affect student learning experiences and educational performance (Dunn and Dunn, 1978; Gregorc, 1977, 1979; Griggs, 1988). Specific student learning styles and specific teaching styles have been identified (Butler, 1985; Barbe & Swassing, 1979; Dunn, Dunn, & Price 1979; Gregorc, 1977, 1979; Guild & Garger, 1985; Keefe, 1979, 1987, 1988; McCarthy, 1981; Hunter, 1979). However, very few research projects have compared to preferential learning strategies and/or instructional modalities with academic performance (Schmeck, 1988).

The purpose of this study was to investigate differences among students' preferential learning styles (preferred learning strategies and instructional modality), and their academic achievement. The null hypotheses tested in this study were as follows:

Null Hypothesis #1: There are no significant academic differences among students' preferential learning strategies.

Null Hypothesis #1a: There are no significant academic differences among students' preferential learning strategies within specific gender groups (male, female).

Null Hypothesis #1b: There are no significant academic differences among students' preferential learning strategies within specific ethnic groups (Anglo, Hispanic, Asian).

Null Hypothesis #2: There are no significant academic differences among students' preferential instructional modalities.

Null Hypothesis #2a: There are no significant academic differences among students' preferential instructional modalities within specific gender groups (male, female).

Null Hypothesis #2b: There are no significant academic differences among students' preferential instructional modalities within specific ethnic groups (Anglo, Hispanic, Asian).

Design

This study utilized a causal-comparative design to examine two independent variables (learning strategy preferences and instructional modality preferences) to determine whether or not significant differences were exhibited in the dependent variable (academic achievement) (Borg & Gall, 1983; Hinkle, Wiersma, Jurs, 1988). Two self-reporting instruments, Reaching The Hard to Reach/Hard to Teach (HTR/HTT) Learning Style Assessment (1988) (Appendix A) and The Learning Channels Inventory (1982) (Appendix B) were used to identify and sort total sample population and specific subgroup nominal data into discrete learning style (AS, CS, AR, CR) and modality (A, V, KT) categories (Reynolds, 1977; Weinstein, 1988). Comparative mean scores for each learning style and modality category were computed from grade point averages (GPA) and the Comprehensive Test of Basic Skills (CTBS) scores.

Instruments

Learning Style Assessment

The HTR/HTT Learning Style Assessment (1988) (Appendix A) was designed as a self-reporting instrument for student use in grades four through nine

(Dunn, Dunn & Price, 1979; Gregorc, 1979; Keefe, 1979, 1987, 1988; Weinstein, 1988). The responses to the instrument determine student preferential learning strategies. The general design is akin to the format utilized by Performance Learning Systems (1982) in their learning style inventory which was designed for adult use. In the HTR/HTT Learning Style Assessment, each learning strategy item is specifically grounded to one of four distinctive learning styles (AS; CS; AR; CR) (Gregorc, 1979; Butler, 1985).

Validity.

It became evident during a pilot study that the Performance Learning Systems' Learning Channels Inventory (1982) learning styles assessment section was inadequate for junior high age students. This was due to the fact that the assessment choices centered upon metric system conversions, a concept which many of the seventh graders had insufficient knowledge. The format of the HTR/HTT Learning Style Assessment (1988) was similar to that of the Performance Learning Systems' adult version. However, the choices were centered upon American Indians, a subject familiar to and more appropriate for younger age groups.

In order to establish concurrent validity, both the HTR/HTT Learning Style Assessment (1988)

(Appendix A) and the Performance Learning Systems' Learning Channels Inventory (1982) (Appendix B) were administered to 150 ninth grade students (Borg & Gall, 1988). The Pearson r nominal data formula resulted in a phi coefficient of .59 which suggested that the adult assessment instrument would be quite inappropriate for this younger age group (Hinkle, Wiersma, Jurs, 1988). Follow-up interviews, conducted on 15% randomly selected participants, confirmed that many of the students did not understand the vocabulary or the choice offerings on the adult assessment instrument (Borg & Gall, 1983).

Construct validity was established by relating the purposes for which the assessment instrument was designed to the nature of the data obtained (Borg & Gall, 1983; Butler, 1985; Dunn & Dunn, 1979; Dunn, Dunn & Price, 1979; Gregorc, 1979; Keefe, 1987, 1988; Weinstein, 1988). The assessment instrument was designed to identify learning strategy preferences which were characteristic of four distinctly different learning styles. Each learning strategy choice was specifically grounded to and reflective of one of four specific learning styles as identified by Anthony Gregorc (1977, 1979) and Katherine Butler (1985) (Appendix C).

Validity through practice and application by practitioners and educators in the field (Dunn & Dunn, 1978; Dunn, Dunn & Price, 1979; Dunn & Griggs, 1988; Keefe, 1979, 1987, 1988; Performance Learning Systems, 1982; Weinstein, 1988) was demonstrated by the utilization of the HTR/HTT Learning Style Assessment with over 350 seventh grade students and over forty teachers in a pilot project related to matching teaching/learning styles conducted at a middle school site. Follow up interviews with teachers and students confirmed validity of preferences identified through self-reporting (Agar, 1980; Borg & Gall, 1983). Over a five year period of time, subsequent applications and practice in the field, were conducted at additional school sites involving over 500 students in grades five, seven, eight, and nine.

Reliability.

As part of a pilot study, reliability was established by test-retest procedure (Borg & Gall, 1983). Seventy-one seventh grade students were tested and after a period of five months were retested. The nominal data formula for the Pearson r resulted in the phi coefficient of .83 (Hinkle, Wiersma, Jurs, 1988). Students were also interviewed and asked to verify

whether or not their responses accurately represented their preferences (Borg & Gall, 1983).

Modality Assessment

The Learning Channels Inventory was designed as a self-reporting instrument by Performance Learning Systems (1982) to assist teachers in the identification and understanding of their own learning styles and how individual learning styles may affect teaching styles (Dunn, Dunn & Price, 1979; Gregorc, 1979; Keefe, 1979, 1987, 1988; Weinstein, 1988). The first section of the inventory was designed to assess modality preferences.

Validity.

Validity through practice and application has been demonstrated (Dunn & Dunn, 1978; Dunn, Dunn & Price 1979; Dunn & Griggs, 1988; Keefe, 1979, 1987, 1988; Weinstein, 1988). Since 1982, The Performance Learning Systems' Learning Channels Inventory (Appendix B) has been widely used throughout the country in teacher training workshops. Construct validity has also been established by grounding each choice to a specific instructional modality (Borg & Gall, 1983).

Further validity through practice and application was demonstrated for the junior high age group when

this assessment instrument was successfully utilized with over 350 seventh grade students and over forty teachers in a pilot project related to matching teaching/learning styles. Subsequent field applications, over a five year period of time, were conducted at additional school sites involving over 500 students in grades, five, seven, eight, and nine.

Reliability.

Reliability for the Performance Learning Systems' modality assessment instrument was established by test-retest procedures (Borg & Gall, 1983). As part of a pilot study, seventy-one seventh grade students were tested and after a period of five months were retested. The nominal data formula for the Pearson r resulted in the phi coefficient of .83. Students were also interviewed to verify whether or not their choices accurately reflected their preferences (Agar, 1980; Borg & Gall, 1983).

Methodology

For the total sample population, mean GPA scores and CTBS scores were computed for each of the four learning style categories (AS, CS, AR, CR) and the three modality categories (A, V, KT). Mean GPA scores and CTBS scores were also computed for the four

learning style and three modality categories for each of the following subgroups: gender (male, female); ethnicity (Anglo, Hispanic, Asian). To determine whether or not significant academic differences occurred among students' preferential learning strategies, a one-way ANOVA analysis of mean score variance was conducted for the total population, as well as for all the subgroups. A one-way ANOVA analysis of mean score variance was also used to determine whether or not significant academic differences occurred among students' preferential instructional modalities for the total population, as well as for all the subgroups (Borg & Gall, 1983; Hinkle, Wiersma, & Jurs, 1988; Huck, Cormier, & Bounds, 1974). A post hoc test, the Tukey-Kramer (TK) was used for the purpose of mean score pairwise comparisons within groups (Hinkle, Wiersma, & Jurs, 1988). A two-tailed test of significance with an alpha level of .05 was utilized in both the one-way ANOVA and the Tukey-Kramer statistical procedures to determine significance of the findings for hypothesis acceptance or rejection. The alpha level of .05 was appropriate for both the type of study and the sample size (Hinkle, Wiersma, & Jurs, 1988).

Setting

The study was conducted in a three year junior high school, grades 7-9, located in the southern coastal section of San Diego County. The school's population was representative of the upper-middle to lower-upper socio-economic level reflected in the surrounding residential community. The school is part of the largest secondary distict in the state of California, with an ADA of over 25,000. Written consent to conduct the study was obtained from the site principal and appropriate district personnel (Appendix F).

This school site has demonstrated and has consistently maintained the highest scores of all the junior high/middle schools of the district on state and standardized tests. The total enrollment of the student body averaged 1680 and reflected the following ethnicity: Native American/Alaskan 1.1%, Asian 13.3%, African American 3.2%, Hispanic 33.1%; Anglo 49.3%. The school's ethnic population represented the highest percentage of non-minority students in the district. The demographics over the past six years indicated that this school's minority populations, particularly the Hispanic and Filipino groups, have been rapidly

increasing. In contrast, the Anglo population has been steadily decreasing.

Sampling

The subjects for the study were drawn from the school's population of 550 eighth grade students. Eighth grade students identified as gifted or enrolled in special education or English as a second language (ESL) classes were excluded. It was felt that these students were not typical of the general population. The ESL students were excluded because of insufficient numbers. In addition, the assessment instruments utilized were not available in their primary language. The sample group consisted of 200 subjects selected by stratified random sampling based on GPA categories: 4.0-3.50; 3.49-2.50; 2.49-1.50; 1.49-0.00. Within these stratified groups, 50 subjects were drawn from each group by systematically sampling every fifth student (Borg & Gall, 1983).

Written approval to conduct the study was granted by the University of San Diego's Committee on the Protection of Human Subjects (Appendix D). Written consent to conduct the study was also secured from the school district and school site (Appendix F).

Prior to any data collection, individual subjects and their parents were advised: (a) of the general purpose of the study; (b) of the amount of time involved by the subject; (c) that anonymity would be preserved through code number; (d) that no individual results would be made available; and (e) that data analysis, interpretation, and dissemination would be reflective of group data only. Written consent was obtained from student subjects and their parents (Appendix E).

Data Collection

The HTR/HTT Learning Style Assessment (1988) (Appendix A) and the Learning Channels Inventory (1982) (Appendix B) were administered to students in groups of eight to ten. Approximately forty-five minutes were required for the administration of both assessments. Students were asked to identify learning strategy preferences and to prioritize their selections. These preferences were reflective of one of four learning style categories (AS, CS, AR, CR) (Appendix D) (Gregorc, 1977, 1979; Butler, 1985) and three modality categories (A, V, KT) (Performance Learning Systems, 1982).

Additional nominal data was collected by separating the results of the four learning style categories and the three modality categories into the subgroups of gender (male, female) and ethnicity (Anglo, Hispanic, and Asian). Individual responses were categorized into appropriate groups based upon identification of individual learning styles, modality preferences, ethnicity, and gender. Individual GPA and CTBS scores were then averaged and mean GPA and CTBS scores were determined for each discrete group.

Assumptions and Limitations

Five assumptions were made concerning the study. It was assumed that:

1. GPAs and CTBS scores are the most appropriate available indicators of academic achievement.

2. Different learning and teaching styles exist and can be identified.

3. Teaching styles and learning styles may be either congruent or incongruent.

4. When teaching and learning styles are incongruent, some learners may be disadvantaged in the learning process.

5. When teaching styles and learning styles are congruent, some learners may be advantaged in the learning process.

One limitation of the study was that the sample population did not adequately represent the lower socio-economic groups. As a result, broad generalizations based solely upon this study should be avoided. A second limitation resulted from the utilization of a causal-comparative design. Such a design precludes conclusions based upon cause and effect relationships.

Summary

A causal-comparative design was utilized to carry out this study. Two independent variables (learning style preferences and instructional modality preferences) were examined to determine if significant differences were exhibited in the dependent variable (academic achievement). Eighth grade students, (special education and ESL students excepted), enrolled at a three year junior high school served as subjects.

A stratified random sample based upon GPA categories was utilized to identify 200 participants. Participants were duly informed of their right and anonymity was maintained throughout the study.

Assumptions and limitations for the study were identified.

Two self-reporting assessment instruments, The HTR/HTT Learning Style Assessment (1988) (Appendix A) and the Performance Learning Systems Learning Channels Inventory (1982) (Appendix B) were utilized in the identification of learning style preferences and instructional modality preferences, respectively. Mean GPA and mean CTBS scores for each category were computed. A one-way ANOVA analysis of mean score variance was conducted for hypothesis testing. A post hoc test, the Tukey-Kramer (TK), was used to determine significant differences in pairwise mean score comparisons. A two-tailed test with a pre-established alpha level of .05 was utilized to assess significance of the results for hypotheses acceptance or rejection.

CHAPTER 4

RESEARCH FINDINGS

Introduction

The purpose of this study was to investigate whether or not there were significant differences among preferential learning styles, (preferred learning strategies and preferred instructional modality), and academic achievement. A causal-comparative design was used to focus on two independent variables (learning style preference and modality preference) and one dependent variable (academic achievement) (Borg & Gall, 1983). An analysis of variance of GPA mean scores and CTBS mean scores was conducted using the one-way classification ANOVA. For the purpose of pairwise comparisons, the Tukey-Kramer (TK) was used. A pre-established two-tailed test of significance at the alpha level of .05 was used to determine hypotheses acceptance or rejection (Hinkle, Wiersma & Jurs, 1988).

Sampling

The sample population was drawn from the general population of 550 eighth grade students. (Students identified as gifted and those enrolled in special education or ESL programs were excluded.) A total of 200 subjects was selected by stratified random sampling based upon GPA categories (4.00-3.50; 3.49-2.50; 2.49-1.50; 1.49-0.00). Systematic sampling was used to select 50 subjects from within each of the stratified groups (Borg & Gall, 1983).

Instrument Administration

As discussed previously in Chapter Three, two self-reporting assessment instruments were used to identify learning style and modality preferences. These assessment instruments were administered consecutively during one forty-five minute session. In order to garner the maximum degree of accuracy of the responses, the assessment instruments were administered to small groups of eight to ten students.

Results of the Investigation Process

Demographic Profile

The sample population consisted of 110 (55%) males and 90 (45%) females (see Table 1). The ethnic distribution was composed of 106 (53%) Anglos, 66 (33%) Hispanics, 24 (12%) Asians, and 4 (2%) African Americans (see Table 2). It should be noted that due to the limited number of African American (only 4), this ethnic category was not included in the data analysis as an ethnic subgroup. They were however, included in the analysis of data for the total sample population and for the gender subgroups (male, female).

Table 1

Distribution by Gender

Group	Number	Percentage
male	110	55
female	90	45
total	200	100

Table 2

Distribution by Ethnicity

Group	Number	Percentage
Anglo	106	53
Hispanic	66	33
Asian	24	12
African American	4	2
total	200	100

Distribution of Learning Style Preferences

Individual learning style preferences were categorized and totaled. Comparative distribution percentages were computed for each of the four learning style categories (AS, CS, AR, CR). Distribution percentages were also computed for learning style preferences for each of the subgroups (gender: male, female; and, ethnicity: Anglo, Hispanic, Asian). The distribution of learning style preferences found in the sample population is displayed in Table 3.

The CR learning style group constituted the highest percentage of students within the total

population (38.5%). The AS group represented the smallest percentage (16.5%). The distribution of the four learning styles preferences within the total population, from the highest to the lowest percentage, was determined to be: CR (38.5%); CS (24.5%); AR (20.5%); and AS (16.5%). Although the percentages varied, this distribution pattern, from highest to lowest of CR, CS, AR, and AS, was also apparent within the Anglo, Hispanic, and Asian subgroups. The distribution pattern among the males was very close to that of the other subgroups, reflecting CR as the highest and CS as the second highest percentage preferences. However, the AR and AS groups tied for third. The females' distribution of preferences varied from that of the other groups. Among the females, the AR demonstrated the highest percentage of preferences followed by CR, CS, and AS (see Table 3).

Among the total population, 63% of the students preferred concrete learning styles (CR, CS) while only 37% indicated a preference for abstract learning styles (AS, AR). It was determined that 41.0% of the total population preferred sequential (left brain dominant) learning styles (AS, CS) while 59.0% preferred random (right brain dominant) styles (CR, AR) (Table 3).

The majority of females (54.5%) preferred left brain dominant learning styles (AS, CS). A majority of

males (61.9%) preferred right brain dominant learning styles (CR, AR). The highest percentage of CR learners were among the male subgroup (49.2%). A higher percentage of males (74.6%) preferred concrete learning styles (CS, CR) to abstract ones (25.4%). Among the females, 51.1% preferred abstract learning styles (AS, AR) while 48.9% indicated concrete style preferences (CS, CR) (Table 3).

Table 3

Distribution of Learning Style Preferences

Group	AS		CS		AR		CR		Total	
	#	%	#	%	#	%	#	%	#	%
Total	33	16.5	49	24.5	41	20.5	77	38.5	200	100
Gender										
male	14	12.7	28	25.4	14	12.7	54	49.2	110	100
female	19	21.1	21	23.4	27	30.0	23	25.5	90	100
Ethnicity*										
Anglo	13	12.3	25	23.6	22	20.8	46	43.3	106	100
Hispanic	16	24.2	18	27.3	11	16.6	21	31.9	66	100
Asian	3	12.5	6	25.0	7	29.2	8	33.3	24	100

* 4 African American students not included in data

Distribution of Instructional Modality Preferences

Individual instructional modality preferences were also categorized and totaled. Comparative distribution percentages were computed for the three modality categories (A, V, KT). Distribution percentages were also computed for modality preferences for each of the subgroups (gender: male, female; ethnicity: Anglo, Hispanic, Asian). The distribution of instructional modality preferences is displayed in Table 4.

Among the total population, the most preferred instructional modality was A (39.5%), followed by KT (32.0%), and V (28.5%). Although specific percentages varied, this preferential distribution pattern was apparent in all the subgroups, except the male. In the male group, the same percentage (35.5%) expressed preference for A and V while the lowest percentage preferred KT (Table 4).

Between the gender subgroups, a higher percentage of females (44.5%) than males (35.5%) preferred A. More males (35.5%) than females expressed a V preference. Fewer males (29.0%) than females (35.5%) indicated a preference for KT (Table 4).

Among the ethnic subgroups, Asians indicated the highest preference for KT modality (33.3%). The Anglo group demonstrated the highest preference for V

(31.1%). The highest preference for A was expressed by the Hispanic group (47.0%) (Table 4).

Table 4

Distribution of Instructional Modality Preferences

Group	A		V		KT		Total	
	#	%	#	%	#	%	#	%
Total	79	39.5	57	28.5	64	32.0	200	100
Gender								
male	39	35.5	39	35.5	32	29.0	110	100
female	40	44.5	18	20.0	32	35.5	90	100
Ethnicity*								
Anglo	37	34.9	33	31.1	36	34.0	106	100
Hispanic	31	47.0	17	25.8	18	27.2	66	100
Asian	9	37.5	7	29.2	8	33.3	24	100

* 4 African American students not included in data

Data Analysis

Mean Scores

Individual learning style preferences were identified and categorized. The GPA of individual subjects within each learning style category was averaged in order to compute a mean GPA for each learning style group (Table 5).

In the total population, the highest learning style GPA mean score was demonstrated by the AS group (2.88) followed by AR (2.67), CS (2.55), and CR (1.86). The Anglo and Hispanic subgroups displayed the same high to low ordered mean score pattern found in the the total population (namely, AS, AR, CS, CR). Within the female and Asian subgroups the highest GPA mean scores were earned by the AS group, followed by AS, CS, AR, and CR. For the males, the AR learning style demonstrated the highest GPA mean score, followed by CS, AS, and CR. Within all the subgroups, the CR learning style group consistently demonstrated the lowest GPA mean scores. And, the AS style, with the exception of the male group, consistently earned the highest GPA mean scores (Table 5).

Within the AS group, the GPA mean scores of the females (3.15), the Anglos (3.30), and the Asians

(3.55) exceeded the total AS group GPA mean score (2.88). The AS GPA mean score for the males (2.52) and the Hispanics (2.51) fell below the total AS GPA mean score (2.88) (Table 5).

The GPA mean scores of the male (2.57), the Anglo (2.65), and the Asian (3.39) all exceeded the CS group GPA mean score (2.55). Two subgroups, the female (2.54) and the Hispanic (2.07), did not (Table 5).

For the CS group, the total GPA mean score (2.55) was exceeded by GPA mean scores of the male (2.57), the Anglo (2.65), and the Asian (3.39). GPA mean scores for the female (2.54) and the Hispanic (2.07) fell below the total CS GPA mean score (Table 5).

The GPA mean scores of the female (2.36), the Asian (2.21), and the Anglo (1.96) all exceeded the CR group GPA mean score (1.86). The subgroups of male (1.75) and Hispanic (1.66) fell below the CR group GPA mean score (Table 5).

Among the various subgroup populations, the highest GPA mean score was earned by the Asian AS (3.55), followed by the Asian CS (3.39), the female AS (3.15), the Anglo AS (3.30), and the Asian AR (3.10). The three lowest GPA mean scores were demonstrated by the Anglo CR (1.96), the male CR (1.75) and the Hispanic CR (1.66) (Table 5).

Table 5

GPA Learning Style Mean Scores

Group	AS	CS	AR	CR
Total	2.88	2.55	2.67	1.86
Gender				
male	2.52	2.57	2.85	1.75
female	3.15	2.54	2.59	2.36
Ethnicity				
Anglo	3.30	2.65	2.87	1.96
Hispanic	2.51	2.07	2.15	1.66
Asian	3.55	3.39	3.10	2.21

Individual instructional modality preferences were also identified and categorized. The GPA of individual subjects within each modality category was averaged in order to compute a mean GPA for each modality group (Table 6).

In the total population, the highest modality GPA mean score was demonstrated by the A (2.50), followed by V (2.49), and KT (2.03). Although the actual mean

scores varied, all of the subgroups (with the exception of the male) displayed this same high to low mean score ordering of A, V, KT. Within the male subgroup the V group earned the highest GPA mean score, followed by A and KT (see Table 6).

Within the A group, the Asian (3.55), the female (2.80), the Anglo (2.66) GPA mean scores exceeded the group mean score (2.50). The A GPA mean scores of the male (2.29) and the Hispanic (2.24) did not (Table 6).

The V GPA mean score for the female (2.58), the Anglo (2.61), and the Asian (3.10) surpassed the V group GPA mean score (2.49). However, the V GPA mean score for the male (2.45) and the Hispanic (2.01) failed to exceed the total group GPA mean score (Table 6).

The GPA mean score for the KT group was determined to be 2.03. The KT GPA mean score was exceeded by the female (2.28), the Anglo (2.08), and the Asian (2.90) subgroups. The subgroups of male (1.78) and Hispanic (1.88) fell below the KT group GPA mean score (Table 6).

Table 6

GPA Modality Mean Scores

Group	A	V	KT
Total	2.50	2.49	2.03
Gender			
male	2.29	2.45	1.78
female	2.80	2.58	2.28
Ethnicity			
Anglo	2.66	2.61	2.08
Hispanic	2.24	2.01	1.88
Asian	3.55	3.10	2.09

The same procedure was followed to compute CTBS mean scores for the four learning styles and the three modality categories (see Tables 7 & 8).

In the total population, the highest learning style CTBS mean score was demonstrated by the AS (67.24), followed by AR (65.40), CS (61.23), and CR (45.00). The subgroups of male, female, and Hispanic, displayed the same high to low ordered CTBS mean score pattern found in the total group (namely AS, AR, CS, CR). Among the Asians, the CS group displayed the highest CTBS mean scores followed by AR, AS, and CR.

For the Hispanic subgroup, the AS style had the highest CTBS mean scores followed by AR, CS, and CR. The AS style demonstrated the highest CTBS mean scores in all the subgroups, with the exception of the Asians. The CR style maintained the lowest CTBS mean scores, with the exception of the Hispanics (see Table 7).

Within the AS group, CTBS mean scores of the male (68.04), female (70.64), Anglo (74.28), and Asian (75.30) exceeded the total AS group CTBS mean score of 67.24. The Hispanic CTBS mean score (64.10) failed to exceed the AS group CTBS mean score (Table 7).

The CTBS mean score for the CS group was 61.23. The subgroups of female (61.53), Anglo (64.91), and Asian (82.23) exceeded the CS total group CTBS mean score. The CTBS mean scores for the male (61.00) and the Hispanic (49.12) subgroups fell below the CS group CTBS mean score (Table 7).

Within the AR group, CTBS mean scores of the female (65.40) and the Asian (76.41) subgroups exceeded the AR mean score of 65.40. However, the CTBS mean scores for the males (65.11), the Anglos (46.90) and the Hispanics (53.10) failed to exceed the AR total group CTBS mean score (Table 7).

The CTBS mean score for the CR group was determined to be 45.00. The following subgroups demonstrated CTBS mean scores higher than the CR total

group CTBS mean score: female (54.93); Anglo (70.22); Asian (51.40). The subgroups of male (40.71) and Hispanic (42.00) did not exceed the total group CTBS mean score (Table 7).

Among the various subgroup populations, the highest CTBS mean score was earned by the Asian CS (82.23) followed by the Asian AR (76.41), the Asian AS (75.30), the female AS (70.64), the Anglo AS (74.28), and the Anglo CR (70.22). The lowest CTBS mean scores were demonstrated by the Anglo AR (46.90), the Hispanic CR (42.00), and the male CR (40.71) (Table 7).

Table 7

CTBS Learning Style Mean Scores

Group	AS	CS	AR	CR
Total	67.24	61.23	65.40	45.00
Gender				
male	68.04	61.00	65.11	40.71
female	70.64	61.53	65.56	54.93
Ethnicity				
Anglo	74.28	64.91	46.90	70.22
Hispanic	64.10	49.12	53.10	42.00
Asian	75.30	82.23	76.41	51.40

In the total population, the highest modality CTBS mean score was earned by the V group (62.20). The second highest CTBS mean score was demonstrated by the A group (58.64). The KT group produced the lowest CTBS mean score (51.84). Although the actual CTBS mean scores varied, the following subgroups demonstrated the same high to low pattern produced by the total group (namely, V highest, A second, and KT lowest). For the subgroups of female and Asian the A group scored the highest CTBS mean score, followed by V and KT (see Table 8).

The CTBS mean score for the A group was 58.64. The following subgroups demonstrated CTBS mean score higher than the total A group CTBS mean score: Asian (80.38); female (64.52); Anglo (61.85). The CTBS mean scores for the male (52.60) and Hispanic (49.34) groups did not exceed the A group CTBS mean score (Table 8).

The CTBS mean score for the V group was determined to be 62.20. The V CTBS mean score was exceeded by the Asian (72.93), the female (63.57), and the Anglo (62.61). The subgroups of male (60.11) and Hispanic (53.64) fell below the V CTBS group mean score (Table 8).

Within the KT group, the female (60.71), the Anglo (53.83), and the Asian (53.14) surpassed the A group CTBS mean score of 51.84. The CTBS mean scores of the

male (42.96) and the Hispanic (48.16) subgroups did not exceed the group CTBS mean score (Table 8).

Table 8

CTBS Modality Mean Scores

Group	A	V	KT
Total	58.64	62.20	51.84
Gender			
male	52.60	60.11	42.96
female	64.52	63.57	60.71
Ethnicity			
Anglo	61.85	62.61	53.83
Hispanic	49.34	53.64	48.16
Asian	80.38	72.93	53.14

Analysis of Mean Score Variances

In addressing each null hypothesis, the ANOVA, one-way classification was employed in the analysis of variance of mean scores. When appropriate, the Tukey-Kramer (TK) procedure was employed to determine the statistical significance of various Q distributions in the pairwise comparisons. The following steps were followed in the analysis of variances in mean scores:

1. GPA mean scores of preferential learning styles (AS, CS, AR, CR) were analyzed by total sample population; gender (male, female); and ethnicity (Anglo, Hispanic, Asian).

2. GPA mean scores of preferential instructional modalities (A, V, KT) were analyzed by total sample population; gender (male, female); and ethnicity (Anglo, Hispanic, Asian).

3. CTBS mean scores of preferential learning styles (AS, CS, AR, CR) were analyzed by total sample population; gender (male, female); and ethnicity (Anglo, Hispanic, Asian).

4. CTBS mean scores of preferential instructional modalities (A, V, KT) were analyzed by total sample population; gender (male, female); and ethnicity (Anglo, Hispanic, Asian).

Using GPA Mean Scores - Examination of Null Hypotheses #1, #1a, #1b: There are no significant academic differences among students' preferential learning strategies.

The one-way ANOVA analysis of GPA mean score variances for learning style preferences was computed for the total population and the subgroups of gender (male, female), and ethnicity (Anglo, Hispanic, Asian). The results are presented in Tables 9 through 14.

In each instance, the F value exceeded the established F critical value for a two-tailed test of significance at the .05 alpha level. The null hypothesis was therefore rejected and the alternative hypothesis was accepted. Significant academic differences among students' preferential learning strategies were found in the total population, as well as in all the subgroups (male, female, Anglo, Hispanic, Asian) (see Tables 9 - 14, respectively).

The Tukey-Kramer (TK) procedure was utilized in the analysis of pairwise comparisons within population groups. A two-tailed test of significance at the .05 alpha level was used to determine Q critical values. Some significant pairwise academic differences among students' preferential learning styles were found within the total sample population (see Table 9.1).

Significant pairwise differences were also found within the subgroup populations of male (Table 10.1), female (Table 11.1), Anglo (Table 12.1), and Hispanic (Table 13.1). No significant pairwise differences were evident in the Asian population (Table 14.1).

Discussion of Data in Tables 9-14.

As displayed in Table 9, one-way ANOVA analysis of GPA mean score variance for the total population revealed an F value of 12.62. This number was considerably larger than the F critical value of 2.11. This indicated that the academic variance among different learning style groups was statistically significant and the null hypothesis was therefore rejected. The TK calculation of Q statistics indicated significant pairwise differences in mean variance between the groups of: CR and CS; CR and AR; CR and AS. Other observed pairwise variance between groups was not of statistical significance.

Table 9

Analysis Learning Styles - Total Population GPA Scores

Source	SS	df	MS	F	F_{cv}
Between	34.25	3	11.4	12.62	2.11
Within	177.02	196	.903		
Total	211.27	199			

Reject H_o at .05.

Table 9.1

TK Calculation of Q - Learning Styles - Total Population GPA Scores

Group	Mean	n_K	Q Statistic		
CR	1.86	77			
CS	2.55	49	5.75*		
AR	2.67	41	6.75*	.92	
AS	2.88	33	7.85*	2.20	1.40

Q_{cv} = 3.63 *p <.05

As shown in Table 10, the analysis of male GPA mean scores produced an F value of 8.82 which exceeded the F critical value of 2.14. This indicated that the academic difference among males' preferential learning styles was statistically significant. The TK revealed that the statistically significant variance was between the groups of: CR and CS; CR and AR. Although the Q statistic of 3.67 for the pairwise variance between the CR and AS groups was high, it failed to exceed the Q critical value of 3.69. Other observed pairwise variance between groups was found not to be of statistical significance (see Table 10.1).

Table 10

Analysis Learning Styles - Male Population GPA Scores

Source	SS	df	MS	F	F_{cv}
Between	21.95	3	7.32	8.82	2.14
Within	88.03	106	.83		
Total	109.98	109			

Reject H_o at .05.

Table 10.1

TK Calculation of Q - Learning Styles - Male Population GPA Scores

Group	Mean	n_K	Q Statistic		
CR	1.75	54			
AS	2.52	14	3.67		
CS	2.57	28	5.13*	.23	
AR	2.85	14	5.50*	1.38	1.27

Q_{cv} = 3.69 *p <.05

As displayed in Tables 11 and 11.1, the academic variance in mean GPA scores among females was determined to be statistically significant. The F value of 3.81 exceeded the established F critical value of 2.16 and the null hypothesis was rejected. The TK calculations of the Q statistic determined that the statistically significant pairwise variance existed between the following groups: CR and AS; AR and AS. Although the Q statistic for variance between CS and AS was fairly high, 3.59, it fell below the Q critical value of 3.72 and was not of statistical significance.

Table 11

Analysis Learning Styles - Female Population GPA Scores

Source	SS	df	MS	F	F_{cv}
Between	7.07	3	2.36	3.81	2.16
Within	53.73	86	.62		
Total	60.80	89			

Reject H_o at .05.

Table 11.1

TK Calculation of Q - Learning Styles - Female Population GPA Scores

Group	Mean	n_K	Q Statistic		
CR	2.36	22			
CS	2.54	21	1.05		
AR	2.59	27	1.53	.33	
AS	3.15	19	4.65*	3.59	3.73*

Q_{cv} = 3.72 *p < .05

The academic difference in learning style preferences demonstrated by the Anglo subgroup proved to be statistically significant. The F value of 11.45 clearly exceeded the F critical value of 2.14 (see Table 12). The TK procedure revealed that the statistically significant variance was between the following learning style groups: CR and CS; CR and AR; CR and AS (see Tables 12 and 12.1). The other observed variance between learning style groups was not statistically significant (see Table 12.1).

Table 12

Analysis Learning Styles - Anglo Ethnic Population GPA Scores

Source	SS	df	MS	F	F_{cv}
Between	25.07	3	8.36	11.45	2.14
Within	74.66	102	.73		
Total	99.73	105			

Reject H_o at .05.

Table 12.1

TK Calculation of Q - Learning Styles - Anglo Ethnic Population GPA Scores

Group	Mean	n_k	Q Statistic		
CR	1.96	46			
CS	2.66	24	4.38*		
AR	2.87	22	5.69*	1.11	
AS	3.30	13	7.05*	2.29	1.54

Q_{cv} = 3.69 *p < .05

As displayed in Table 13, the calculated F value for the Hispanic subgroup of 2.33 exceeded the F critical value of 2.18. The null hypothesis was thus rejected. The TK procedure revealed that the only statistically significant pairwise comparison variance occurred between the groups of CR and AS. The Q statistic for all other pairwise comparisons fell well below the Q critical value of 3.74 and therefore were determined not to be of statistical significance (see Table 13.1).

Table 13

Analysis Learning Styles - Hispanic Ethnic Population GPA Scores

Source	SS	df	MS	F	F_{cv}
Between	6.84	3	2.28	2.33	2.18
Within	60.63	62	.98		
Total	67.47	65			

Reject H_o at .05.

Table 13.1

TK Calculation of Q - Learning Styles - Hispanic Ethnic Population GPA Scores

Group	Mean	n_K	Q Statistic		
CR	1.66	21			
CS	2.07	18	1.86		
AR	2.15	11	1.96	.29	
AS	2.51	16	3.86*	1.83	1.29

Q_{cv} = 3.74 *p < .05

The analysis of variance among learning style group GPA mean scores for the Asian subgroup produced the F value of 3.32 which exceeded the F critical value of 2.38. The null hypothesis was therefore rejected. The academic variance among the Asian learning style groups was statistically significant (see Table 14). The TK procedure revealed that the greatest pairwise variance was between the CR and AS groups. However, the calculation of the Q statistic indicated that none of the observed pairwise variance between groups was of statistical significance (see 14.1).

Table 14

Analysis Learning Styles - Asian Ethnic Population GPA Scores

Source	SS	df	MS	F	F_{cv}
Between	6.78	3	2.26	3.32	2.38
Within	13.64	20	.68		
Total	20.42	23			

Reject H_o at .05.

Table 14.1

TK Calculation of Q - Learning Styles - Asian Ethnic Population GPA Scores

Group	Mean	n_K	Q Statistic		
CR	2.21	8			
AR	3.10	7	2.97		
CS	3.39	6	3.69	.90	
AS	3.55	3	3.35	1.13	.39

Q_{cv} = 3.96 *p < .05

Using GPA Mean Scores - Examination of Null Hypotheses #2, #2a, #2b: There are no significant academic differences among students' preferential instructional modalities.

The one-way ANOVA analysis of GPA mean score variance for preferential instructional modalities was computed for the total population and the subgroups of gender (male, female), ethnicity (Anglo, Hispanic, Asian). The results are presented in Tables 15 through 20. In four instances, the total population (Table 15) and the subgroups of male (Table 16), Anglo (Table 17), and Asian (Table 18) the F value exceeded the established F critical value for a two-tailed test of significance at the .05 alpha level. In these

instances, the null hypothesis was rejected and the alternative hypothesis was accepted. A significant academic difference was found among students' preferential instructional modalities in the total population group, as well as in the male, Anglo, and Asian subgroups.

In the analysis of variance for two subgroups, the female population (Table 19) and the Hispanic population (Table 20), the F value did not exceed the established critical value for a two-tailed test of significance at the .05 alpha level. In these two instances the null hypothesis was accepted.

The Tukey-Kramer (TK) procedure was utilized in the analysis of pairwise comparisons within population groups. A two-tailed test of significance at the .05 alpha level was used to determine Q critical values. A significant pairwise academic difference was found within the total population (Table 15.1), as well as within the male (Table 16.1), Anglo (Table 17.1), and Asian (Table 18.1) subgroups.

Discussion of Data in Tables 15 - 20.

As displayed in Table 15, the academic differences in GPA mean scores among preferential modality groups for the total population was determined to be

statistically significant. The computed F value of 4.29 exceeded the F critical value of 2.33. The pairwise variance of 3.62 between KT and A groups was statistically significant. The variance between the KT and V groups was relatively high, 3.07. However, it failed to exceed the Q critical. The variance between V and A was clearly of no significance (see Table 15.1).

Table 15

Analysis Modalities - Total Population GPA Scores

Source	SS	df	MS	F	F_{cv}
Between	9.44	2	4.72	4.29	2.33
Within	217.19	197	1.10		
Total	226.63	199			

Reject H_o at .05.

Table 15.1

TK Calculation of Q - Modalities - Total Population GPA Scores

Group	Mean	n_K	Q Statistic	
KT	2.03	64		
V	2.49	57	3.07	
A	2.50	79	3.62*	.08

Q_{cv} = 3.31 *p < .05

The academic difference among the mean GPA scores for the male modality preferences (Table 16) was found to be statistically significant. The calculated F value of 4.44 exceeded the F critical value of 2.35. The pairwise comparisons revealed that the significant variance occurred between the KT and the A group. Although the variance between the KT and V groups was relatively high, 3.12, it failed to exceed the Q critical value of 3.37. The variance between V and A was not significant (see Table 16.1).

Table 16

Analysis Modalities - Male Population GPA Scores

Source	SS	df	MS	F	F_{cv}
Between	8.44	2	4.22	4.44	2.35
Within	101.52	107	.95		
Total	109.96	109			

Reject H_o at .05.

Table 16.1

TK Calculation of Q - Modalities - Male Population GPA Scores

Group	Mean	n_K	Q Statistic	
KT	1.78	32		
V	2.31	39	3.12	
A	2.45	39	3.94*	.94

Q_{cv} = 3.37 *p < .05

As shown in Table 17, the Anglo subgroup's variance in preferential instructional modalities was also found to be significant. The F value of 3.43 exceeded the F critical value of 2.36. The greatest observed pairwise variance of 3.28 occurred between the KT and A groups. However, it failed to exceed the Q critical value of 3.37 by .09. The other pairwise variances also failed to exceed the Q critical value. Therefore, none of these pairwise variances was determined to be of statistical significance (see Table 17.1).

Table 17

Analysis Modalities - Anglo Ethnic Population GPA Scores

Source	SS	df	MS	F	F_{cv}
Within	7.20	2	3.60	3.43	2.36
Between	107.30	102	1.05		
Total	114.50	104			

Reject H_o at .05.

Table 17.1

TK Calculation of Q - Modalities - Anglo Ethnic Population GPA Scores

Group	Mean	n_K	Q Statistic	
KT	2.08	36		
V	2.61	33	2.94	
A	2.67	36	3.28	.33

Q_{cv} = 3.37 *p < .05

The analysis of instructional modality preference and academic variance among the Asian subgroup indicated that the difference was statistically significant. The F value of 11.41 greatly exceeded the F critical value of 2.57 (see Table 18). The calculation of the Q statistic revealed significant variance between the groups of KT and A; KT and V. The variance between the V and A groups was not significant (see Table 18.1).

Table 18

Analysis Modalities - Asian Ethnic Population GPA Scores

Source	SS	df	MS	F	F_{cv}
Within	9.35	2	4.68	11.41	2.57
Between	8.54	21	.41		
Total	17.89	23			

Reject H_o at .05.

Table 18.1

TK Calculation of Q - Modalities - Asian Ethnic Population GPA Scores

Group	Mean	n_K	Q Statistic	
KT	2.09	8		
V	3.10	7	4.21*	
A	3.55	9	6.64*	1.96

Q_{cv} = 3.57 *p < .05

The female subgroup's analysis of GPA mean score variance among preferred instructional modalities yielded an F value of 2.29. This value was close to the F critical value of 2.38 but failed to exceed it. The null hypothesis was therefore accepted (see Table 19).

Table 19

Analysis Modalities - Female Population GPA Scores

Source	SS	df	MS	F	F_{cv}
Within	4.79	2	2.40	2.29	2.38
Between	91.01	87	1.05		
Total	95.80	89			

Accept H_o at .05.

As displayed in Table 20, the analysis of GPA mean scores variance among the Hispanic subgroup's preferential instructional modalities produced an F value of .77. This value failed to exceed the established F critical value of 2.18. Therefore, the null hypothesis was accepted.

Table 20

Analysis Modalities - Hispanic Ethnic Population GPA Scores

Source	SS	df	MS	F	F_{cv}
Within	1.58	2	.79	.77	2.18
Between	64.41	63	1.02		
Total	65.99	65			

Accept H_o at .05.

Using CTBS Mean Scores - Examination of Null Hypotheses #1, #1a, #1b: There are no significant academic differences among students' preferential learning strategies.

The one-way ANOVA analysis of CTBS mean score variance for learning styles was computed for the total population and the subgroups of gender (male, female) and ethnicity (Anglo, Hispanic, Asian). The results are presented in Tables 21 through 26. In five instances, the total population (Table 21) and the subgroups of male (Table 22), Anglo (Table 23), Hispanic (Table 24), and Asian (Table 25) the F value exceeded the established F critical value for a two-tailed test of significance at the .05 alpha level.

In each instance, the null hypothesis was rejected and the alternative hypothesis was accepted. Significant academic differences were found among students' preferential learning strategies in the total population, as well as in the male, Anglo, Hispanic, and Asian subgroups.

In the analysis of variance for the female subgroup (Table 26), the F value did not exceed the critical value for a two-tailed test of significance at the .05 alpha level. In this instance, the null hypothesis was accepted.

The Tukey-Kramer (TK) procedure was utilized in the analysis of pairwise comparisons within population groups. A two-tailed test of significance at the .05 alpha level was used to determine Q critical values. A significant pairwise academic differences among students' preferential learning styles was found within the total population (Table 21.1), as well as within the male (Table 22.1), Anglo (Table 23.1), Hispanic (Table 24.1), and Asian (Table 25.1) subgroups.

Discussion of Data in Tables 21 - 26.

As displayed in Table 21, the analysis of CTBS mean score variance among preferential learning style groups for the total population was found to be

statisically significant. The calculated F value of 9.77 exceeded the F critical value of 2.11. The TK procedure determined that the variance between groups was statistically significant for the following pairs: CR and CS; CR and AR; CR and AS. The greatest variance was demonstrated between the CR and AS groups. The variance between other pairs was not significant (see Table 21.1).

Table 21

Analysis Learning Styles - Total Population CTBS Scores

Source	SS	df	MS	F	F_{cv}
Within	18,406.09	3	6135.36	9.77	2.11
Between	123,507.17	196	630.13		
Total	141,913.26	199			

Reject H_o at .05.

Table 21.1

TK Calculation of Q - Learning Styles - Total Population CTBS Scores

Group	Mean	n_k	Q Statistic		
CR	45.00	77			
CS	61.23	49	4.57*		
AR	65.40	41	5.75*	1.17	
AS	67.24	33	6.26*	1.38	.42

Q_{cv} = 3.63 *p < .05

The male subgroup's variance in CTBS mean scores among learning style groups was significant. The F value of 9.61 exceeded the F critical value of 2.14 (Table 22). Statistically significant pairwise variance occurred between the groups of: CR and CS; CR and AR; CR and AS. The variance between other pairs was not statistically significant (see Table 22.1).

Table 22

Analysis Learning Styles - Male Population CTBS Scores

Source	SS	df	MS	F	F_{cv}
Within	15,133.50	3	5,044.50	9.61	2.14
Between	55,665.44	106	525.15		
Total	70,798.94	109			

Reject H_o at .05.

Table 22.1

TK Calculation of Q - Learning Styles - Male Population CTBS Scores

Group	Mean	n_K	Q Statistic		
CR	40.71	54			
CS	61.00	28	5.10*		
AR	65.11	14	5.02*	.76	
AS	68.04	14	5.62*	1.31	.48

Q_{cv} = 3.69 *p < .05

As indicated in Table 23, the CTBS mean score variance among preferential learning style groups within the Anglo subgroup was judged to be statistically significant. The F value of 9.02 exceeded the F critical value of 2.14. The calculation of the Q statistic indicated that the significant pairwise variance occurred between: CR and CS; CR and AR; CR and AS. The greatest pairwise variance occurred between the groups of CR and AS. The variance between the other pairs proved not to be statistically significant (see Table 23.1).

Table 23

Analysis Learning Styles - Anglo Ethnic Population CTBS Scores

Source	SS	df	MS	F	F_{cv}
Within	13,362.62	3	4,454.21	9.02	2.14
Between	50,378.65	102	493.91		
Total	63,741.27	105			

Reject H_o at .05.

Table 23.1

TK Calculation of Q - Learning Styles - Anglo Ethnic Population CTBS Scores

Group	Mean	n_K	Q Statistic		
CR	46.90	46			
CS	64.91	25	4.67*		
AR	70.22	22	5.25*	1.07	
AS	74.28	13	5.51*	1.72	.69

Q_{CV} = 3.69 * < .05

As displayed in Table 24, the academic difference in CTBS mean scores among the Hispanic subgroup's preferential learning styles was determined to be statistically significant. The F value of 2.89 exceeded the F critical value of 2.18. The greatest pairwise variance was between the CR and AS groups. However, the calculation of the Q statistic indicated that none of the pairwise variances was statistically significant (see Table 24.1).

Table 24

Analysis of Learning Styles - Hispanic Ethnic Population CTBS Scores

Source	SS	df	MS	F	F_{cv}
Within	4,567.91	3	1,522.64	2.89	2.18
Between	32,720.87	62	527.76		
Total	37,288.78	65			

Reject H_o at .05.

Table 24.1

TK Calculation of Q - Learning Styles - Hispanic Ethnic Population CTBS Scores

Group	Mean	n_K	Q Statistic		
CR	42.00	21			
CS	49.20	18	1.40		
AR	53.10	16	2.15	.69	
AS	64.10	11	3.63	2.29	1.69

Q_{cv} = 3.74 *p < .05

As displayed in Table 25, the analysis of academic variance in CTBS mean scores among the Asian subgroup's learning style preferences was determined to be of statistical significance. The F value of 2.76 exceeded the F critical value of 2.38. The greatest pairwise variance observed was between the groups of CR and CS; CR and AR; CR and CS; respectively.

Table 25

Analysis Learning Styles - Asian Ethnic Population CTBS Scores

Source	SS	df	MS	F	F_{cv}
Within	4,032.60	3	1,344.20	2.76	2.38
Between	9,755.48	20	487.77		
Total	13,788.08	23			

Reject H_o at .05.

Table 25.1

TK Calculation of Q - Learning Styles - Asian Ethnic Population CTBS Scores

Group	Mean	n_K	Q Statistic		
CR	51.40	8			
AS	75.30	3	2.25		
AR	76.41	7	3.02	.10	
CS	82.23	6	3.61	.63	.67

Q_{cv} = 3.96 * < .05

The variance in CTBS mean scores for the female's learning styles was not significant. The calculated F value of 1.54 did not exceed the F critical value of 2.16. The null hypothesis was accepted (Table 26).

Table 26

Analysis Learning Styles - Female Population CTBS Scores

Source	SS	df	MS	F	F_{cv}
Within	2,826.48	3	942.16	1.54	2.16
Between	52,639.82	86	612.09		
Total	55,466.30	89			

Accept H_o at .05.

Using CTBS Mean Scores - Examination of Null Hypotheses #2, #2a, #2b: There are no significant academic differences among students' preferential instructional modalities.

The one-way ANOVA analysis of CTBS score variance for preferential instructional modalities was computed for the total population and the subgroups of gender, (male, female), ethnicity (Anglo, Hispanic, Asian). The results are presented in Tables 27 through 32.

In two instances, the male subgroup (Table 27) and the Asian subgroup (Table 32) the F value exceeded the established F critical value for a two-tailed test of significance at the .05 alpha level. In each of these instances, the null hypothesis was rejected and the alternative hypothesis was accepted. Significant academic difference was found among students' preferential instructional modalities in the male and Asian subgroups.

In the analysis of variance for the total population (Table 27) and the subgroups of female (Table 29), Anglo (Table 30), Hispanic (Table 31) the F value did not exceed the establised critical value for a two-tailed test of significance at the .05 alpha level. In these instances, the null hypothesis was accepted.

The Tukey-Kramer (TK) procedure was utilized in the analysis of pairwise comparisons within the male and Asian populations, respectively. A two-tailed test of significance at the .05 alpha level was used to determine Q critical values. Significant pairwise academic difference among students' preferential instructional modalities was found in the male subgroup population (Table 28.1). No significant pairwise academic difference among students' preferential instructional modalities was found in the Asian subgroup (Table 32.1).

Discussion of Data in Tables 27-32.

The variance in CTBS scores among preferred instructional modality groups for the total population was not determined to be statistically significant. Although the calculated F value of 2.23 was only .10 less than the F critical value, it did not exceed it. Therefore, the null hypothesis was accepted (Table 27).

Table 27

Analysis Modalities - Total Population CTBS Scores

Source	SS	df	MS	F	F_{cv}
Within	2,917.64	2	1,458.82	2.23	2.33
Between	128,700.17	197	653.30		
Total	131,617.81	199			

Accept H_o at .05.

The academic variance in CTBS mean scores among the male's preferred instructional modalities proved to be statistically significant. The calculated F value of 4.22 exceeded the F critical value of 2.36. The only pairwise variance of significance was that of KT and A (see Tables 28 and 28.1).

Table 28

Analysis Modalities - Male Population CTBS Scores

Source	SS	df	MS	F	F_{cv}
Within	5,169.78	2	2,584.89	4.22	2.36
Between	65,614.82	107	613.22		
Total	70,784.60	109			

Reject H_o at .05.

Table 28.1

TK Calculation of Q - Modalities - Male Population CTBS Scores

Group	Mean	n_K	Q Statistic	
KT	42.96	32		
V	52.60	39	2.24	
A	60.11	39	3.99*	1.75

Q_{cv} = 3.37 *p < .05

The female subgroup's variance in CTBS scores for preferred modalities was not significant. The calculated F critical value of .21 failed to exceed the F critical value of 2.38. The null hypothesis was accepted (see Table 29).

Table 29

Analysis Modalities - Female Population CTBS Scores

Source	SS	df	MS	F	F_{cv}
Within	265.71	2	132.86	.21	2.38
Between	54,817.16	87	630.08		
Total	55,082.87	89			

Accept the H_o at .05.

The difference among CTBS scores for the Anglo subgroup was determined not to be statistically significant. The calculated F value of 1.36 failed to exceed the F critical value of 2.36. Therefore, the null hypothesis was accepted (see Table 30).

Table 30

Analysis Modalities - Anglo Ethnic Population CTBS Scores

Source	SS	df	MS	F	F_{cv}
Within	1,680.96	2	840.48	1.36	2.36
Between	63,867.33	103	620.07		
Total	65,548.29	105			

Accept H_o at .05.

The difference in CTBS mean scores among the Hispanic subgroup's preferred modalities failed to be statistically significant. The calculated F value of .27 did not exceed the F critical value of 2.39. Thus, the null hypothesis was accepted (see Table 31).

Table 31

Analysis Modalities - Hispanic Ethnic Population CTBS Scores

Source	SS	df	MS	F	F_{cv}
Within	298.53	2	149.27	.27	2.39
Between	34,255.88	63	543.74		
Total	34,554.41	65			

Accept H_o at .05.

As displayed in Table 32, the variance in CTBS mean scores among preferred instructional modalities for the Asian subgroup was significant. The F value of 3.03 exceeded the F critical value of 2.57. The greatest pairwise variance was between the KT and A groups. The TK procedure indicated that the observed pairwise variance was statistically significant (see Table 32.1).

Table 32

Analysis Modalities - Asian Ethnic Population CTBS Scores

Source	SS	df	MS	F	F_{cv}
Within	3,285.69	2	1,642.85	3.03	2.57
Between	11,375.01	21	541.67		
Total	14,660.70	23			

Reject H_o at .05.

Table 32.1

TK Calculation of Q - Modalities - Asian Ethnic Population CTBS Scores

Group	Mean	n_K	Q Statistic	
KT	53.14	8		
V	72.93	7	2.27	
A	80.38	9	3.38	.89

Q_{cv} = 3.57 *p < .05

Summary

GPA Mean Scores and Learning Style Preferences

In addressing null hypotheses #1,#1a, and #1b, (There are no significant academic differences among student's preferential learning strategies.), an analysis of GPA mean score variance was computed for the total population and for the subgroups of gender (male, female), and ethnicity (Anglo, Hispanic, Asian) (see Tables 9-14, respectively). In each instance, the F value exceeded the established F critical value for a two-tailed test of significance at the .05 alpha level (see Table 33). The null hypothesis was therefore rejected and the alternative hypothesis was accepted. Significant academic difference among students' preferential learning styles was found in the total population, as well as in all the subgroups (male, female, Anglo, Hispanic, Asian) (see Table 33).

An analysis of pairwise comparisons within specific groups determined that there was significant pairwise academic difference among students' preferential learning styles within the total population (Table 9.1), and for the subgroup populations of male, (Table 10.1), female (Table 11.1), Anglo (Table 12.1), and Hispanic (Table 13.1). No significant pairwise

difference was evident in the Asian population (Table 14.1).

GPA Mean Scores and Instructional Modality Preferences

In addressing null hypotheses #2, #2a, and #2b, (There are no significant academic differences among students' preferential instructional modalities.), analysis of GPA mean score variance was computed for the total population and for the subgroups of gender (male, female), and ethnicity (Anglo, Hispanic, Asian) (see Tables 15-20, respectively). In four instances, the total population (Table 15) and the subgroups of male (Table 16), Anglo (Table 17), and Asian (Table 18) the F value exceeded the established F critical value. Statistically significant academic difference was found among students' preferential instructional modalities. In these instances, the null hypothesis was rejected and the alternative hypothesis was accepted (see Table 33).

Analysis of pairwise comparisions within specific groups determined that there was significant academic difference among students' preferential instructional modalities within the total population (Table 15.1), as well as within the male (Table 16.1), Anglo (Table 17.1), and Asian (Table 18.1) subgroups.

The analysis of variance of GPA mean scores for two subgroups, the female (Table 19) and the Hispanic (Table 20), indicated that the academic difference among students' preferential instructional modalities was not statistically significant. In these two instances, the null hypothesis was accepted (see Table 33).

CTBS Mean Scores and Learning Style Preferences

In addressing null hypotheses #1, #1a, #1b (There are no significant academic differences among students' preferential learning strategies.), an analysis of CTBS mean score variance was computed for the total population and for the subgroups of gender (male, female) and ethnicity (Anglo, Hispanic, Asian) (see Tables 21-26, respectively). The academic difference among students' preferential learning styles was determined to be statistically significant in five instances, including the total population (Table 21), and the subgroups of male (Table 22), Anglo (Table 23), Hispanic (Table 24), and Asian (Table 25) (see Table 33).

The analysis of variance for the female subgroup (Table 26) indicated that the academic difference was

not statistically significant. In this instance, the null hypothesis was accepted (see Table 33).

CTBS Mean Scores and Instructional Modality Preferences

In addressing null hypotheses #2, #2a, #2b (There are no significant differences among students' preferential instructional modalities.), an analysis of CTBS mean score variance was computed for the total population and for the subgroups of gender (male, female), and ethnicity (Anglo, Hispanic, Asian) (see Tables 27-32, respectively). In two instances, the male subgroup (Table 27) and the Asian subgroup (Table 32) a statistically significant academic difference was found among students' preferential instructional modalities. In these instances, the null hypothesis was rejected and the alternative hypothesis was accepted (see Table 33). A statistically significant difference in CTBS mean score pairwise comparison was also found among students' preferential instructional modalities within the male subgroup population (Table 28.1).

The analysis of variance of CTBS mean scores for the total population, as well as for the female (Table 29), Anglo (Table 30), Hispanic (Table 31), subgroups indicated that the academic difference among students'

instructional modalities was not statistically significant. In these instances, the null hypothesis was accepted (see Table 33).

Table 33

Rejection or Acceptance of the Null Hypotheses

Learning Styles	GPA		CTBS	
	reject	accept	reject	accept
Total	X		X	
Male	X		X	
Female	X			X
Anglo	X		X	
Hispanic	X		X	
Asian	X		X	

Modalities	GPA		CTBS	
	reject	accept	reject	accept
Total	X			X
Male	X		X	
Female		X		X
Anglo	X			X
Hispanic	X			X
Asian	X		X	

CHAPTER 5

DISCUSSION OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

Educators are charged with the responsibility of developing and delivering educational experiences which will prepare students to successfully participate as enlightened citizenry in a democratic society. Within our educational system, some students experience academic success while many others still fail to achieve and fall short of realizing their academic potential. Educators continue to be challenged and frustrated by their inability to cultivate the academic potential of low achieving students.

As noted in the literature review, since the 1970's, educators have begun to recognize and accept concepts associated with learning and teaching styles. Specific learning and teaching styles have been identified and described. Researchers and practitioners have documented that individuals do have differing preferential learning styles and that not all individuals prefer to learn in the same manner. It has been suggested by practitioners that learning/teaching

styles may be either congruent or incongruent. The issue then becomes: Are low achievers academically disadvantaged if their preferred learning style is incongruent with the predominant teaching styles utilized in the traditional educational system? Many noted researchers and educators suggest that this is the case (Barbe & Swassing, 1979; Butler, 1985; Dunn & Dunn, 1978; Dunn & Griggs, 1988; Gregorc, 1979; Guild & Garger, 1985; Hunter, 1976; Keefe, 1989; Rubenzer, 1985; Trautman, 1979; Vitale-Meister, 1982).

The purpose of this study was to investigate whether or not there were any significant differences among students' preferential learning styles (preferred learning strategies and instructional modalities) and their academic achievement. A causal-comparative design was utilized to examine two independent variables (learning strategy preferences and preferential instructional modalities) and one dependent variable (academic achievement). Two self-reporting instruments, Reaching the Hard to Reach/ Hard To Teach (HTR/HTT) Learning Style Assessment and The Learning Channels Inventory were used to identify and sort total population and specific subgroup nominal data into discrete learning style and modality categories (Reynolds, 1977; Weinstein, 1988). GPA

scores and CTBS scores, respectively, were used as determinants of academic achievement.

Subjects for the study were drawn from 550 eighth grade students attending a three year junior high school. The sample population was representative of the upper-middle to lower-upper socio-economic level of the surrounding community. The sample population was selected by stratified random sampling based upon GPA categories (4.0-3.50; 3.49-2.50; 2.49-1.50; 1.49-0.00). Within these stratified groups, 50 subjects were drawn from each group by systematically sampling every fifth student. Prior to any data collection, individual subjects and their parents were advised of the purpose of the study, the amount of time involved by the subject, preservation of anonymity, and reporting of results reflective of group data only. Written consent was obtained from individual subjects and their parents.

Through the administration of two self-reporting instruments, nominal data was collected and sorted into four learning style categories (AS, CS, AR, CR) and three modality categories (A, V, KT). Additional nominal data was collected by separating each learning style and modality category into subgroups by gender (male, female) and ethnicity (Anglo, Hispanic, and Asian). Within each of these nominal categories

individual GPA scores and CTBS scores, respectively were averaged and group GPA mean scores and group CTBS mean scores were determined. The one-way ANOVA analysis of mean score variance was conducted for hypothesis testing. A post hoc test, the Tukey-Kramer (TK) was used to determine significant differences in pairwise mean score comparisons. The level of significance for hypothesis acceptance was pre-established at the .05 alpha level.

Summary of Literature Review Findings

An extensive review of the literature pertaining to learning styles yielded a vast amount of information and led to some interesting conclusions. As documented in Chapter Two, it was noted that:

1. Learning styles do exist.

2. Learning styles can be identified, assessed, diagnosed, described, categorized, and labeled.

3. Learning styles are defined as individual, personal, and unique patterns of perceiving, processing, evaluating, organizing, and communicating information.

4. Learning style concepts, theories, and early applications are rooted in multi-sensory methodologies

originated by Montessori and popularized by the special education movement of the 1960's.

5. Learning style concepts and theories are paralleled by teaching style concepts and theories.

6. The learning styles of teachers are reflected in their own individual teaching styles.

7. Learning styles may be congruent or incongruent with a given teaching style.

8. Learning styles which are primarily left brain dominant, auditory/visual in preference (mental processing characterized by linear, sequential, logical, verbal, reality-based, temporal, symbolic, abstract modes of consciousness) may be more congruent with the majority of teaching styles currently representative of the traditional education system.

9. Learning styles which are primarily right brain dominant, visual/kinesthetic-tactual in preference (mental processing characterized by holistic, concrete, random, intuitive, nonverbal, fantasy-oriented, non-temporal, analogic modes of consciousness) may be incongruent with the majority of teaching styles currently representive of the traditional education system.

10. Learning/teaching style applied research projects document that teachers can easily and

effectively accommodate for individual student learning style preferences within the educational process.

11. Research on learning/teaching styles suggests that academic performance may be improved when individual learning style preferences are accommodated.

12. Practitioners suggest that all learning styles may best be accommodated when a variety of instructional methods and learning activities are presented and when the learners are allowed to freely select activities most congruent with their preferred learning style.

13. Learning styles have been a topic of considerable interest among educators in the 1970's and 1980's because matching teaching/learning styles appears to be a promising method for improving the educational process and academic improvement for all learners, including low achievers.

14. Learning styles which are incongruent with teaching styles may disadvantage the learners and place them at risk of not realizing their full academic potential.

Summary of Research Findings

The purpose of this study was to investigate differences among students' preferential learning

styles (preferred learning strategies and instructional modality), and their academic achievement. The null hypotheses tested in this study were as follows:

Null Hypothesis #1: There are no significant differences among students' preferential learning strategies.

Null Hypothesis #1a: There are no significant academic differences among students' preferential learning stategies within specific gender groups (male, female).

Null Hypothesis #1b: There are no significant academic differences among students' preferential learning strategies within specific ethnic groups (Anglo, Hispanic, Asian).

Null Hypothesis #2: There are no significant academic differences among students' preferential instructional modalities.

Null Hypothesis #2a: There are no significant academic differences among students' preferential instructional modalities within specific gender groups (male, female).

Null Hypothesis #2b: There are no significant academic differences among students' preferential instructional modalities within specific ethnic groups (Anglo, Hispanic, Asian).

A total of 24 separate tests of significance were calculated (Tables 9-32). In 18 instances, the null hypothesis was rejected and the alternative hypothesis was accepted. The null hypothesis was accepted in only six instances (see Table 33, p. 130).

Using GPA mean scores, statistically significant academic differences were found to exist among students' preferential learning styles and among students' preferential instructional modalities in both total population groups, as well as in all subgroups, except for one (modalities-female) (see Table 33, p. 130).

Using CTBS mean scores, statistically significant academic differences were found to exist among students' preferential learning styles in the total population, as well as in all subgroups except one, (Anglo) (see Table 33, p. 130). Statistically significant academic differences among CTBS scores and preferential instructional modalities were only apparent for the subgroups of male and Asian (see Table 33, p. 130).

Academic Variance Among Preferential Learning Style and Preferred Modality Groups

In this study, a significant academic difference clearly existed among preferential learning style groups. For the total population, the abstract-sequential (AS) style demonstrated the highest GPA mean score. The abstract-random (AR) group ranked second. The third highest GPA mean score was earned by the concrete-sequential (CS) group. The concrete-random (CR) learning style produced the lowest GPA mean score.

Within the various subgroups of gender and ethnicity, the GPA mean scores produced some interesting variations. With the exception of the male subgroup, the highest GPA mean score belonged to the abstract-sequential (AS) learning style group. The lowest GPA mean score was consistently held by the concrete-random (CR) group (see Table 5, p. 81).

The academic variance among the three modalities and the GPA mean scores revealed a pattern as consistent as that seen among the learning style groups (Table 6, p. 83). In the total population, the auditory (A) group garnered the highest GPA mean score while the kinesthetic-tactual (KT) modality group earned the lowest GPA mean score. The GPA point

variance between the auditory (A) and the visual (V) groups was very small.

Within the gender and ethnicity subgroups, the auditory groups displayed the highest GPA mean scores. The male subgroup earned the highest visual GPA mean score. The kinesthetic-tactual (KT) group, without exception, earned the lowest GPA mean scores (see Table 6, p. 83).

Using CTBS mean scores as an indicator of academic achievement, the total population CTBS mean score variance among learning styles was found to be significant. The CTBS mean score variance pattern for the total population mirrored the pattern seen among the GPA total population scores (Table 7, p. 85). The abstract-sequential (AS) style demonstrated the highest CTBS score. The abstract-random (AR) ranked second. The third highest was concrete-sequential (CS). The concrete-random (CR) group earned the lowest CTBS score.

Within the gender and ethnicity subgroups, the CTBS mean scores produced a pattern similar to that found in the GPA mean scores. Namely, the abstract-sequential (AS) groups scored highest while the concrete-random (CR) groups earned the lowest mean CTBS scores. There were two exceptions to this pattern. Within the Asian subgroup the CS ranked higher than the

AS. And, within the Anglo subgroup, the AR scored lower than the CR (see Table 7, p. 85).

When CTBS mean scores were measured against modality preference, the kinesthetic-tactual (KT) group consistently scored the lowest in the total population, as well as within each of the subgroups. No identifiable pattern was demonstrated by the auditory and visual groups (see Table 8, p. 87).

Discussion of Research Findings

Both GPA and CTBS mean scores were used in this study as measurements of academic achievement. However, the discussion of research finding will focus primarlily upon the GPA mean scores because: (a) the GPA is the standard used (rightly or wrongly) to measure academic achievement by educational institutions and society in general; (b) the CTBS used in this study was over ten years old and reflected out-dated norms; (c) the analysis of CTBS mean score data, even in the instances where the null hypothesis was accepted, demonstrated a pattern of variance, as cited earlier, which was consistent with the general variance patterns revealed by the analysis of GPA mean scores.

One of the striking findings in this study was the noted pattern found among and between the abstract-

sequential (AS) and the concrete-random (CR) learners; and, the auditory (A) and kinesthetic-tactual (KT) learners. These groups consistently demonstrated statistically significant academic variance.

It was expected that the AS/A learning style would earn the highest GPA mean scores because it may be viewed as congruent with teaching styles typically found in the traditional school system. This style has been characterized by left brain processing with strong verbal and listening skills. Preferred learning strategies focus on instructional activities which stimulate intellectual abstractions including: reason and logic; theory and concepts; ideas and information; analysis and evaluation; intellectual problems; reading; logical outcomes; meeting-of-the-minds strategies (Butler, 1985; Gregorc, 1977, 1979; Vitale-Meister, 1982).

The AR/A learning style earned the second highest GPA mean scores. This was unexpected because it is regarded as a right brain dominant learning style which relies on random/global rather than sequential processing. However, the AR learning style prefers abstract learning activities over concrete ones. The abstractions for the AR learner are fantasy-oriented, tied to thematic, relational, metaphoric, imaginative, illustrative, and emotional modes of consciousness. It

should be noted that the AR learner prefers group learning activities and the recent movement to utilize cooperative learning strategies may be advantageous to the AR learner (Butler, 1985; Gregorc, 1977; 1979; Smey-Richman, 1988; Vitale-Meister, 1982). Considering that the traditional education system deals predominantly in the abstract rather than the concrete it seems reasonable that the AR group earned the second highest scores.

It was expected that the CS/A style would earn the second highest scores because it is characterized by left brain processing with a preference for learning strategies which are task-oriented, structured, factual, detailed, logical, and sequential. However, the CS learner prefers practical, real world, hands-on, concrete learning experiences to the abstract presentations typically presented in the traditional system. The CS learner prefers to actively participate in structured, realistic learning situations which will produce real and practical results (Butler, 1985; Gregorc, 1977, 1979; Vitale-Meister, 1982). Viewing learning styles from concrete versus abstract preferences it is understandable why the CS mean scores ranked below that of AS and AR.

The fact that the lowest mean scores were demonstrated by the concrete-random/kinesthetic-tactual

(CR/KT) learning style was expected. This particular learning style has been described as learning by doing (through movement, tactual, physical, and emotional experience). It has been characterized by right brain processing. Preferred learning strategies focus on learning activities which are global, open-ended, and unstructured including: problem solving; exploration; investigation, divergent thinking; open-ended activity with freedom of choices; experiential; discovery-oriented approaches. The CR learner also prefers hands-on, concrete learning experiences in which they may be physically active (Butler, 1985; Gregorc, 1977, 1979; Vitale-Meister, 1982). The CR style is perhaps the most incongruent within the traditional educational system. The CR learner appears to be the most challenging to teach and least effectively taught learner (Hunter, 1976; Vitale-Meister, 1982).

It was expected that the distribution of learning styles would fall somewhat equally among the four groups. However, it was determined that the groups were not equally distributed and that the distribution in terms of GPA mean scores were unequal as well. It was startling to learn that the most academically successful learning styles represented the smallest percentage of the total population (AS: 16.5%, 2.88; AR: 20.5%, 2.67) while the least academically

successful learning styles represented the largest percentage of the population (CR: 38.5%, 1.86; CS: 24.5%, 2.55) (see Table 3, p. 76 & Table 5, p. 81).

It was expected that the distribution of modality preferences would be evenly distributed. However, this was not the case. The A group represented the highest percentage (39.5%). The KT group, which demonstrated the lowest GPA mean score (2.03) represented the second highest percentage (32.0%) of the population. The V group garnered 28.5% of the total population (Table 4, p. 78).

As cited in Chapter Two, it has been suggested that traditional instructional presentations tend to be congruent with some learning styles and incongruent with others (Barbe & Swassing, 1979; Dunn & Dunn, 1978; Gregorc, 1979; Hunter, 1976; McCarthy, 1980; Vitale-Meister, 1982). It may be suggested by the results of this study that the abstract-sequential/ /auditory (AS/A) learner may be advantaged in this particular learning environment. Conversely, the concrete-random/kinesthetic-tactual (CR/KT) learner may be disadvantaged. It may be further implied that the abstract processors (AS, AR) may be advantaged while those students who prefer concrete learning experiences may be disadvantaged (CR, CS). A and V learners may be advantaged over KT learners.

Research studies suggest that ethnic acculturation factors may influence individual learning style preferences and these preferences may in turn affect academic achievement. The issue of language was not a factor in this study for either the Asians or the Hispanics. Although most subjects were thought to be third generation residence, some may have been second or fourth generation Asians and Hispanics. Regardless, ethnic acculturation factors may have been influential in shaping learning style preferences.

In the results of this study, the highest GPA mean scores observed in all the learning style groups were earned by the Asian subgroup (Table 5, p. 81). The Asian subgroup also demonstrated the highest GPA mean scores in all three of the modality groups (Table 6, p. 83). Asians have been previously cited as demonstrating characteristics consistent with left hemispheric processing learning styles. They also do well in competitive learning situations. Generally speaking, there is pressure from the home environment to excel academically in school (Smey-Richman, 1988; Performance Learning Systems, 1983). It is conceivable that in this particular learning environment, the Asians may have been advantaged.

The second highest GPA mean scores in the learning style groups was earned by the Anglo subgroup

(Table 5, p. 81). The Anglos also demonstrated the second highest GPA mean scores in all three of the modality groups (Table 6, p. 83). It has been cited in the literature that Anglo students demonstrate field-independent (left hemisphere) learning styles more than minority students do (African Americans; Native Americans; Hispanic Americans) (Browne, 1986; Smey-Richman, 1988). It also has been noted that Anglos prefer competitive learning situations to non-competitive ones (Performance Learning Systems, 1983; Smey-Richman, 1988).

The Hispanic subgroup demonstrated the lowest GPA mean scores in all four learning style groups (Table 5, p. 81). They also produced the lowest GPA mean scores in the three modality groups (Table 6, p. 83). Hispanics have been cited as demonstrating characteristics consistent with field-dependent (right hemispheric) learning styles and they prefer cooperative rather than competitive learning situations. Some cultural clashes may have come into play for Hispanic students depending upon the extent to which the home environment reflects the values promoted by the traditional school system. (Browne, 1986; Smey-Richman, 1988). In this particular learning environment, the Hispanics may have been disadvantaged.

Previous research studies suggest that gender factors, both biological and acculturated, may influence individual learning style preferences. These preferences may in turn affect academic achievement.

In this study, more females than males preferred left brain dominant learning style (AS) while almost twice as many males than females preferred right brain dominant learning style (CR). More auditory females than males expressed a preference for abstract learning styles (AS, AR). On the other hand, more males than females expressed a preference for concrete learning styles (CR, CS) (Table 3, p.76). Auditory females produced higher GPA mean scores than did the auditory males. Visual males earned higher GPA mean scores than the visual females (Table 6, p.83). Female GPA mean scores exceeded those of the male in all three modalities (A, V, KT), as well as in the AS and CR learning style groups. As a result, in this particular learning environment, it may be suggested that females may have been advantaged over males.

The results of this study support implications suggested by previous research that gender may influence preferential learning styles and modality strengths and thus impact academic performance (Blakeslee, 1980; Browne, 1986; Durden-Smith & deSimone, 1983; Gilligan, 1982; Performance Learning

Systems, 1983; Restak, 1979; Smey-Richman, 1988). In this particular learning environment, females may have been advantaged over males because they demonstrated left brain learning style preferences which are characterized by strong verbal and auditory skills. They also expressed preferences toward abstract learning styles (Blakeslee, 1980; Durden-Smith & deSimon, 1983; Performance Learning Systems, 1983; Restak, 1979). Females more than males appear to be socially connected to their environment and may exhibit behaviors patterns which better meet the expectations of their teachers (Gilligan, 1982; Smey-Richman, 1988). The demonstrated preferences for right brain dominant and concrete learning styles may have disadvantaged the males.

In the analysis of the learning style group GPA mean scores, the null hypothesis was rejected for the total group, as well as for all the subgroups (Table 33, p. 130). In the analysis of modality group GPA mean scores, the null hypothesis was also rejected for the total group, as well as all the subgroups, with the exception of the female subgroup (Table 33, p. 130).

In the analysis of the learning style CTBS mean scores, the null hypothesis was rejected for the total group and all the subgroups with the exception of the female subgroup. This pattern, with the exception of

the female group, was consistent with the results of the analysis of the GPA mean scores (Table 33, p. 130).

The analysis of modality group variance, using CTBS mean scores, revealed some difference from that of the GPA mean score analysis of variance. Using CTBS mean scores, the null hypothesis was rejected in only two instances, the subgroups of male and Asian. The null hypothesis was accepted for the total population, as well as for the subgroups of female, Anglo, and Hispanic (Table 33, p. 130). However, using the GPA mean score analysis of variance not only was the null hypothesis rejected for the subgroups of male and Asian but also for the total population, and the Anglo and Hispanic subgroups (Table 33, p. 130).

It should be noted, that even in these instances where the null hypothesis was accepted, the patterns displayed in group CTBS mean score variance, although not statistically significant, remained consistent with GPA mean score results. As enumerated in Table 7, p. 85 and Table 8, p. 87: (a) the A group displayed higher CTBS mean scores than the KT group; (b) the AS group earned the highest CTBS mean scores while the CR group displayed the lowest CTBS mean scores; (c) females earned higher CTBS mean scores than males in all learning style and modality groups; (d) Asians consistently demonstrated the highest CTBS mean scores,

followed by the Anglos; (e) the Hispanics demonstrated the lowest CTBS mean scores.

Although the CTBS test used in this study reflected outdated norms, the data derived from the CTBS mean scores, (the acceptance of the null hypothesis for learning style: female; modalities: total group; female; Anglo; and Hispanic), does raise intriguing questions. Does a normed reference test, such as the CTBS, reflect a more objective measure of learned skills and knowledge then that of the GPA? The second question then raised concerns the extent to which teacher bias toward student gender, ethnicity, and/or learning style preference influences teacher expectation and evaluation in the assignment of grades to individual students. Do the differences in academic achievement result from teacher's biases rather than from differences within the learner? These issues open a very different direction for further research.

Conclusions

It can be concluded as a result of this study that significant academic differences do occur among students' preferential learning style groups and preferred modality groups. Both among and within groups, the abstract-sequential (AS) learning style

consistently earned the highest level of academic achievement. The concrete-random (CR) learning style consistently demonstrated the lowest level of academic achievement. The auditory (A) modality group achieved the highest academic scores. The kinesthetic-tactual (KT) modality group consistently earned the lowest scores.

The following groups demonstrated the highest levels of academic achievement among the total population and/or within the various subgroup groups: Asian AS/A (3.55); Asian CS/A (3.39); Anglo AS/A (3.30); female/A (3.15); Asian AR/A (3.10); Anglo AR/A (2.87); male AR/V (2.85). The lowest levels of academic achievement were demonstrated by: Hispanic AR/KT (2.15); Hispanic CS/KT (2.07); male CR/KT (1.75); Hispanic CR/KT (1.66). It could be concluded from this particular study that Asians, Anglos, and females who demonstrated learning style preferences characterized by left brain processing, abstract as opposed to concrete learning experiences, coupled with auditory modality were the most academically successful. It could be further concluded from this study that Hispanics, and males who demonstrated learning style preferences characterized by right brain processing, concrete as opposed to abstract learning experiences, and who also indicated a preference for kinesthetic-

tactual modality were the least academically successful.

The results of this study reinforce information cited in the literature review which suggest that some learning styles (left brain dominant/abstract/auditory/visual) may be more congruent with traditional teaching styles while other learning styles (right brain dominant/concrete/kinesthetic-tactual/visual) are incongruent. Further, the results of this study support the view that an individual's learning style preference may predispose the learner toward academic advantage or disadvantage in the learning environment. (Barbe & Swassing, 1979; Dunn & Dunn, 1978; Gregorc, 1979; Hunter, 1976; Vitale-Meister, 1984).

Recommendations For Further Study Based on Results of This Study

Research into the area of teaching/learning styles has been on the increase the past ten years. However, little research has focused upon academic success and learning style preferences. This study has not only contributed to the literature but also suggests the following recommendations for further study:

1. A longitudinal study, utilizing an experimental design, should be conducted in order to determine

whether or not a cause and effect relationship exists among students' preferential learning styles, preferred instructional modalities, and academic achievement. The experimental group would consist of those students identified in this study whose learning styles preferences seem to place them at academic risk. They would be assigned to teachers using congruent teaching styles. The control group should consist of students whose learning style identifies them as also at academic risk. They would be taught in the traditional manner. No effort would be made to match teaching/learning styles. The effect of matching/ teaching learning styles would be measured by tracking and comparing the academic progress of the two groups using GPA mean scores over a significant period of time.

2. Conduct a similar study in which:
(a) lower socio-economic students are adequately represented in the sample population.
(b) African American students are adequately represented in the sample population.

3. Conduct a study to analyze learning style and modality preferences of students who are transferred to alternative programs, continuation schools and/or dropout of school.

4. Conduct a study to analyze learning style and modality preferences of students who are repeatedly referred to assistant principals for disruptive classroom behavior or other serious disciplinary problems.

5. Examine the extent to which gender and cultural factors influence and shape individual student's learning style and instructional modality preferences.

6. Examine the extent to which ethnicity and acculturation may influence individual student's instructional modality and learning style preferences.

7. Survey the teaching styles among secondary teachers to gather broad baseline data.

8. Investigate learning style preferences and preferred instructional modalities among limited English proficient students to determine:

(a) whether or not ESL student populations display the same distribution of learning style and modality preferences as do English only speakers.

(b) Determine dominant learning styles of ESL students who do not exit ESL programs.

(c) Survey the teaching styles of ESL teachers.

9. There is a need to examine the objectivity of teachers in the assignment of grades to determine to what extent teacher bias may impact on individual student GPA's.

Educators must recognize the fact that students do in fact have differing preferential learning styles and appreciate and capitalize on this diversity. Although this study did not attempt to determine a cause and effect relationship between preferential learning styles and academic achievement, it has determined that a statistically significant variance exists among preferential learning styles, modalities, and academic achievement. As evidenced by the results of this study, it is suggested that some students may be placed at an advantage or disadvantage in learning environments due to their specific learning style preferences.

In order to provide the optimum learning environment for all learners, a consistent effort must be made to accommodate different learning styles. Teachers should utilize a variety of learning strategies appropriately designed for all learning styles (AS, CS, AR, CR). Students should be made aware of their own preferential learning styles and instructional modality preferences. Finally, students should also be given the opportunity to select from a variety of learning activities.

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Appendix A

Hard to Reach/Hard to Teach Learning Style Assessment

Appendix B

Learning Channels Modality Inventory

Appendix C

Learning Strategies Congruent With Specific Learning Styles

LEARNING PREFERENCES

ABSTRACT/SEQUENTIAL
SPECIAL LEARNING CHANNEL:
THE INTELLECT

Abstract sequential learners produce their best natural work by using approaches that require extensive amounts of reading, gathering ideas and information, finding out what the "experts" say, analyzing and evaluating the causes, problems, and results of events, actions, and ideas. Ways to learn most commonly mentioned by abstract sequentials are:

reading
writing essays
working alone
learning content
using theories
working in the library
working with a plan of study, but without competition and time pressures

ABSTRACT/RANDOM (global)
SPECIAL LEARNING CHANNEL:
THE EMOTIONS:

Abstract randoms produce their best, natural work by using approaches that require: interpretations and explanations rather than exact answers; communication through artistic media; reading for emotional enjoyment; personalized meaning; and opportunities to work with others. Preferred means to learn most commonly mentioned by abstract randoms are:

group discussion
filmstrips
using themes
role play
short lecture
music
arts
humor
drama
peer groups
movies
television
use of fantasy
imagination
personalized work
interpersonal and people oriented subjects

CONCRETE/SEQUENTIAL
SPECIAL LEARNING CHANNEL:
USES PHYSICAL SENSES TO TAKE IN INFORMATION AS WELL AS TO CREATE PRODUCTS

Concrete sequentials produce their best, natural work by using approaches that require: structure and pattern, details and facts, practical problems, realistic points, products and results. Preferred means to learn most commonly cited by concrete sequential learners are:

hands-on experiences
demonstrations
results-oriented work
computers
field trips
practical reading
learning packets
short lectures
exact assignments
mechanical/technical problems
useful ideas
checklists
worksheets
flowcharts
data
outlines
short-term projects
practical assignments
labs
summaries
apprenticeships
how-to discussions
action involvement
charts

CONCRETE/RANDOM (global)
SPECIAL LEARNING CHANNEL:
INTUITION

Concrete randoms produce their best, natural work by using approaches that require problem solving, open-ended options, different ways to arrive at answers, and independent work. The preferred means to learn most commonly mentioned by concrete randoms learners are:

problem solving
creating products
experiments
options
few restrictions
unusual solutions
games and simulations
independent study
unusual solutions
open-ended activities
inventing practical ideas

Appendix E

Subject Participation Consent Form

PARENTAL INFORMED CONSENT FORM

Explanation, purpose, and procedures:

Your eighth grade child has been randomly selected to participate in an educational research project. This original field research in education is being conducted as a disseration project in the area of teaching/learning styles. The researcher is interested in determining whether or not there are significant differences in students' preferred learning strategies and modality preferences, and their academic achievement.

- No risks are anticipated.
- Participants will complete a self-reporting assessment instrument designed to identify and prioritize their preferred learning activities and instructional modality preferences. This will involve approximately one class period of time.
- Participation in this study is completely voluntary and the subject may withdraw at any time.
- Confidentiality will be strictly maintained for the individual subject and data collected will be treated and analyzed in group categories, not on an individual basis.
- Subjects will be given an explanation as to the purpose of the study and there will be ample opportunities to ask questions.
- Current research in education suggests that student and teacher awareness of teaching/learning styles may generate greater levels of active learning and positive academic experiences on the part of the student. The focus of this study is to determine whether or not there are significant differences in learning style preferences and academic achievement.

We the undersigned, understand the above explanations, and on that basis, consent is given for my child to voluntarily participate in this educational research project.

_____ _____
Signature of Parent/Guardian Date

_____ _____
Signature of Student Date

_____ _____
Signature of Researcher Date

_____ _____
Signature of Witness Date

Done at _____, _____.
city state

Appendix F

District and Site Participation Consent

Bonita Vista Junior High School

Sweetwater Union High School District

650 OTAY LAKES ROAD
CHULA VISTA, CALIFORNIA 92010
(619) 691-5690

March 6, 1990

The Sweetwater Union High School District is aware of and approves of the educational field research being conducted by Sally J. Bottrofff-Hawes at Bonita Vista Junior High School. This research will become part of a doctoral dissertation study under the supervision of the School of Education, University of San Diego.

The target population is composed of eighth grade students (excluding identified GATE and Special Education students). The focus of the research is to determine whether or not there are any significant differences between preferential learning style, modality strength, and academic achievement. Participation is voluntary with parent permission. Students will be asked to complete two self-assessment instruments requiring approximately one class period of time. The results will be held confidential and the data will be analyzed and discussed solely in terms of nominal data categories.

Approved:

_____ Date 3/5/90
Dr. Jeffrey Schaeffer
Director, Instructional Support Services

_____ Date 3/5/90
Mr. Gerald LaRussa
Principal, BVJ