A STUDY OF CORRELATIONS BETWEEN LEARNING STYLES OF STUDENTS AND THEIR MATHEMATICS SCORES ON THE TEXAS ASSESSMENT OF ACADEMIC SKILLS TEST

Rosalind D. Kopsovich, B.S. M.Ed.

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APPROVED:

Hoyt Watson, Ph.D., Major Professor
Patricia Moseley, Ph.D., Minor Professor
Gary Anderson, Ed.D., Committee Member
John Stansell, Ed.D., Chair of the Department of
Teacher Education and Administration
M. Jean Keller, Ed.D., Dean of the College of
Education
C. Neal Tate, Ph.D., Dean of the Robert B.
Toulouse School of Graduate Studies

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The problem of this study was to determine whether learning styles of students affect their math achievement scores on the Texas Assessment of Academic Skills Test. The research questions addressed relevant to this study were:

1. Is there a positive correlation between students' learning styles and their achievement test scores in mathematics?
2. Is there a positive correlation between specific sub group's (as deemed by the state of Texas) and gender's learning styles and their achievement test scores in mathematics?

The Pearson Product Moment Correlation coefficient and the Point-biserial correlation analysis was applied to the data collected from 500 fifth grade students attending a North Texas Intermediate school. The significance level was established at the .05 level. Part of the data was the student's responses to the Learning Style Inventory by Dunn, Dunn and Price.

The findings established that the learning style preferences of all students in the area of persistence significantly impacted their math achievement scores. Gender and ethnicity were mitigating factors in the findings.

These learning style preferences significantly impacted achievement in the following ways:

- Caucasian students' preference of a high level of persistence in completing a difficult task.
- Hispanic students' preference for a warm learning environment and motivational factor of pleasing the teacher.
- Afro-American students' preference for kinesthetic learning.
- Female students' learning style preferences appear in:
  - the design of the learning environment
  - the need for intake of food and/or drink
  - a high level of responsibility
  - a high sense of self-motivation , of teacher and of parent motivation
- Male students' learning style preferences appear in:
  - a warm learning environment
  - a high level of responsibility
  - the need for intake of food and/or drink
  - a high sense of teacher and of parent motivation
  - a late morning learning

In summary, the author suggests that supplying the teachers with information concerning students' learning style preferences will benefit student achievement.

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CHAPTER I

INTRODUCTION

Background

Educational testing has increased dramatically over the last fifty-years. The high interest in the design (criterion-reference vs. norm-referenced) and the administration of standardized tests has been the focal point of many articles, educational journals and periodicals (Popham, 1998).

The growth in educational testing in this country has increased due to the advent of accountability of educational institutions. There was one state that had a mandated assessment program in 1960 and by 1985 thirty-two states had some form of standardized student assessment. By 1990, every state in the United States had some form of a mandated student assessment program. Public school students are estimated to take 127 million standardized tests annually. Due to increasing mandates, these tests are an integral part of present day curriculum in schools (National Commission on Testing and Public Policy [NCTPP], 1990).

Because of the rapid increase in state mandated testing policies, there has been a significant rise in the dollar amount spent on tests and educational testing services at all levels of the educational setting. There has been an increase of approximately 400% in real dollars spent on testing materials and related services from 1955 through 1995. In forty years sales of testing materials has increased from $30,000,000 in 1955 to over $100,000,000 in 1995 (Popham, 1998).

Not only has educational testing increased in dollars spent but also in the interest of researchers and the public sector. Evidence of this can be clearly illustrated by the number of articles printed concerning educational testing and student assessment. In the decade of 1980-1990, Educational Leadership published over one hundred articles concerning student evaluation, assessment, tests and measurements. This is a startling comparison from the five articles published within a nine-year span: from 1940 – 1949 (NCTPP, 1990). With the increased concern over student achievement and performance evaluation as well as the accountability factor of schools to the community, evaluations and assessments continue to dominate the professional periodicals and teacher training curriculum. Thus, educational testing and student assessment has become a major business.

The data gathered from the testing or assessment of students from state mandated tests is another form of evidence of the growth of educational testing. Since the 1960's the rise of data from these tests has evolved to include but are not limited to:

1. Entrance and exit from kindergarten
2. Grade promotion
3. Remedial class placement
4. Requirements for high school graduation. (*TEA Technical Digest*, p. 65)

Statewide testing not only affects individual student's educational opportunities, but also affects school systems. The factor of accountability is a major issue that leads to massive testing programs. Accountability is being implemented at all levels of the school districts. The rating of the school district, which is in direct relationship to student performance on standardized testing, affects overall ratings of the principal, of the campus and of the individual teacher. This accountability factor is ever present in American schools. The released student scores are purported to inform students, parents and educators about student progress and achievement toward meeting minimum expectations or standards, which are mandated by the state.

Texas has adopted an accountability system for all public schools. This statewide minimum competency test, which is criterion referenced and referred to as the Texas Assessment of Academic Skills Test, better known as TAAS, is such an accountability system. Even though the name of the test and the grade configuration of the targeted testing population have changed over the last twelve years, the basic concept of state mandated testing has continually evolved. A form of mandated student evaluation has been in existence in Texas since 1980.

The state mandated testing program now includes testing of students in grades three through eight and in grade ten. These tests examine their academic ability in reading and mathematics. At grades four, eight and ten, a student’s writing sample is required and assessed by a scale score. The tenth grade test is an exit level examination and is a demonstration of minimum competency of the above-mentioned skills. This exit level examination is required for high school graduation. A student may take the exit level examination a total of eight times to achieve a competency rating high enough to graduate (Texas Education Agency, TAAS Bulletin, 1997).

The distinction of the individuality of students can be illustrated by the diversity of their test scores. When most students begin school, their test scores are comparable but their experiences are varied (Popham, 1998). As their formal education continues, most students in a specific classroom are taught in the same style – the style most compatible to that teacher. Just as each student possesses different types of knowledge from his/her experience, so does each student process information differently to complete the learning cycle. As a result of the students' hereditary factors, their particular life experiences and the demands of their environment, students develop learning styles that emphasize certain learning abilities over others (Guild and Garger, 1985).

The learning styles of students should influence the assessment and the teaching of students. Assessment works as a continuum. Aiding students with their individual interests and ways of thinking lies at one end of the learning chain. At the other end of the learning chain lies the more standardized ways of knowing and doing things that society has deemed as important. In the middle of the chain are individualized ways of understanding and expressing knowledge (Kolb, 1984). At every level of educational attainment, learning styles of students are apparent. Adapting the idea that individuals receive and process information differently should be a controlling factor in the way we teach. Student achievement affects their academic placement in enrichment or remediation programs while in school and also affects their acceptance or rejection by institutions of higher learning.

The thesis of learning styles is that individuals vary considerably in how they learn. Any given person has academic or learning strengths that are determined by a combination of hereditary and environmental influences. These strengths, which translate into preferences to learn and to communicate visually, orally, spatially and tactilely are one's learning style. Other considerations, which affect how an individual learns, are for example, but not limited to, quiet or noisy learning environment, a formal or relaxed environment or peer or solitary learning environment.

There are many who believe that certain learning styles are better suited to learning certain kinds of knowledge or subject content. That theory is what this study will attempt to determine concerning the subject of mathematics.

Statement of the Problem

The problem to be addressed in this research is to determine whether learning styles of 5th grade students affect their scores on the mathematics portion of the Texas Assessment of Academic Skills test.

Purpose of the Study

The purposes of this study are:

- To provide a correlation of the similarities and differences in 5th grade students' learning styles and their achievement scores in mathematics.
- To provide information to persons concerned with how 5th grade students learn and whether learning styles affect their achievement, especially in mathematics.

Research Questions

The study attempts to answer the following questions:

1. Is there a correlation between 5^{th} grade students' learning styles and their standardized math test scores?
2. Is there a positive correlation between specific sub groups of 5^{th} grade students' learning styles and their math standardized test scores?
3. Is there a positive correlation between male and female 5^{th} grade students' learning styles and their math standardized test scores?

Hypothesis

1. There will be no significant differences in the math TAAS test scores of 5^{th} grade students with different learning styles as determined by Dunn, Dunn and Price.
2. There will be no significant differences in the math TAAS test scores of 5^{th} grade Caucasian students with different learning styles.
3. There will be no significant differences in the math TAAS test scores of 5^{th} grade Hispanic students with different learning styles.
4. There will be no significant differences in the math TAAS test scores of 5^{th} grade Afro-American students with different learning styles.
5. There will be no significant difference in the math TAAS test scores of 5^{th} grade male and female students with different learning styles.

Limitations of the Study

Limitations of this study include:

1. The population is limited to 5^{th} grade students in a north Central Texas school district.
2. Learning styles are limited to those of the Learning Style Inventory identified by Dunn, Dunn & Price.
3. There will be no consideration of the various types of teaching styles these students are exposed to.

Definition Of Terms

<u>AUDITORY</u>	This term is used to identify a learning preference of an individual who can learn best when initially listening to verbal instructions.
<u>COGNITIVE-DEVELOPMENT</u>	This term is used to identify when an individual is ready to perceive, to organize, to classify or to label various environmental factors. This term is equated to the work of Jean Piaget and his theory on child development and thinking.
<u>CRITERION-REFERENCED ASSESSMENT</u>	An approach to testing in which an individual's score on a test is interpreted by comparing it to a pre-specified standard of performance.
<u>DESIGN of CLASSROOM</u>	A term used to describe the learners' preferences for a physical learning environment. This environmental element of learning style is thought to be biological and related to an individual's physical being. The term has two diverse elements: A. Formal – This term is used to describe a learning environment that is characteristic of a conventional classroom. B. Informal – This term is used to describe a learning environment that is characteristic of a less conventional classroom setting. The learner might be lying on the floor, lying on pillows or lounging in a chair while concentrating or learning difficult concepts.

EXPERIENTIAL LEARNING THEORY	A theory of learning that approaches learning as a life-long process. It is a theory that individuals do learn from their experiences.
FUNCTIONS OF TIME	This term is closely related to the chronobiology of the individual. Each individual displays a preference for learning during the peak level of the energy curve, which occurs during a 24-hour period.
KINESTHETIC	This term is used to identify an individual's learning style that requires whole body movement and/or real life experiences to absorb and retain material to be learned.
LEARNING STYLE INVENTORY (LSI)	A comprehensive instrument designed and created by Rita Dunn, Kenneth Dunn and Greg Price to assess individual's preferred learning style.
NORM-REFERENCED ASSESSMENT	An approach to testing in which an individual's score on a test is interpreted by comparing it to the scores earned by a norming group.
PRAGMATISM	The application of experimentalism which is a liberal philosophy concerning the theory of reality of change.
SCHOOL	The operational unit to which a student is assigned.
SCHOOLING	This word is used synonymously with education.
TEXAS ASSESSMENT OF ACADEMIC SKILLS (TAAS)	The state-mandated test of specific objectives in reading, writing and mathematics. The test is given annually to students in grades 3 through 8 and grade 10.
VISUAL	This term is used to identify an individual learning style whose primary perceptual strength is visual and is able to recall events and concepts that has been read or observed.

Significance of Study

Mathematics is a form of reasoning and consists of thinking in a logical manner, formulating and testing conjectures, making sense of concepts, formulating inferences, conclusions and judgments as well as justifying them. Mathematics is more than calculation and memorization of basic facts and manipulation of symbols. Students who truly understand or make sense of mathematical concepts are not just manipulating symbols or following rules invented by others to solve problems. They are applying rules and inventing solutions by using logical thinking and reasonableness of solutions. The terms “logical thinking” and “reasonableness in problem solving” are areas that are assessed on the Texas Assessment of Academic Skills Test.

The learning of math must be personally constructed by students as they try to make sense of solutions, communication and written symbols. Scientific constructivism theory, which is grounded in Piaget’s Cognitive Theory of Development, emphasizes abstractions and reflection of knowledge as a continuum for learning math. This theory is closely related to the Experiential Learning Theory in the fact that abstraction and reflection of knowledge is based on individuals past experiences. Abstraction is the process by which the mind selects, combines and registers in the memory a collection of items by degrees of experience. The term abstraction is not a new term and has been discussed by theorists for centuries. It is the current research of Howard Gardner and learning style theorists that have resurrected the scientific constructivism theory and its role in the learning of math.

Just as abstractions is an important element of learning math, so is the reflection of concepts. Reflection is the process of the mind, which integrates the reasoning process resulting from abstraction and applying this reasoning to real world situations of problem solving.

In scientific constructivism accounts of learning, abstraction is the fundamental mental mechanism by which new mathematical knowledge is generated. Reflection, on the other hand, is the conscious process of mentally replaying the experiences, actions or mental processes and the considerations of how the results are formulated (Wilson and Bennett, 1994).

The results of the scientific constructivism theory are cyclical. Students cycle through phases of action, both physical and mental, reflection and abstraction in such a manner that enables them to integrate related abstractions into sophisticated mental modes of mathematical and logical thinking. Without this cyclical sequence of mental models, students' learning about mathematical symbols is syntactic and totally disconnected from real world situations. Research has repeatedly shown that rote learning of syntactic rules for manipulating symbols results in a lack of knowledge of problem solving but an astute capability for rote learning of basic mathematical facts.

The use of rote learning of mathematical skills is necessary, however, the use of manipulatives is also necessary. The integration of rote learning and mathematical manipulation, help form reasoning skills as well as critical thinking and problem solving strategies.

If the issue of math coverage and achievement testing of math concepts are aligned, then students test results will be valid. If, however, the myth of "if mathematics is covered then students will learn it" and teaching to the test are emphasized, then students will not only be unsuccessful in achievement test scores, but also unsuccessful in retaining problem solving skills needed in real life situations.

A lack of understanding of the testing process creates the “teach to the test” phenomena. Because of state mandated testing for math achievement and not teaching mathematical concepts and reasoning by using scientific constructivism theory or understanding how student’s learn, many U.S. students are not as successful as other countries, as reported by the Third International Mathematics and Science Study (TIMSS).

How students learn, as well as the essence of learning mathematics must be combined and analyzed through current research to increase student’s performance on standardized mathematical testing (Bell, 1989). According to Johnston, the odds for success in the classroom increase when students and teachers understand how people differ in their approaches to learning tasks and then use that understanding to create strategies for learning (Educational Leadership, 1997).

Teachers should not label learners according to their style; just help them work for balance and wholeness. A major function of education is to shape student’s attitudes and orientations toward learning, to instill positive attitudes toward learning and a desire for knowledge and to develop effective learning skills. Early educational experiences shape or mold individual learning styles; students are taught how to learn (Kolb, 1985). A major function of education is to instill in students a positive attitude toward learning, a thirst for knowledge and to develop effective learning skills. Early educational and social experiences shape individual learning styles; students are taught how to learn. This learning occurs in patterns and reflects how individuals tend to store and recall information best. This information is stored and processed in the brain. As new findings and research in left/right brain functions appeared, a correlation between learning styles and hemisphericity began to emerge (Dunn, 1989).

The differences in learning styles and their relationship to hemispheric styles were noted in research conducted by Cody in 1983. This experimental research reported that left hemisphere students in grades five through twelve preferred a conventional classroom setting and employed visual rather than tactile or kinesthetic resources during the learning process. It was also noted that identified right hemispheric individuals were strongly peer motivated and employed auditory and tactile learning resources rather than visual. Because learning is the process whereby development occurs, to be aware of how a student learns can benefit the learner and the teacher.

CHAPTER II

REVIEW OF RELATED LITERATURE

The review of the related literature is divided into three main sections. The first section will discuss the historical background, the development of the concept, distinctions between cognitive style and learning style as well as a description of various instruments to identify learning styles. Section two will be an overview of research pertaining to standardized testing and what it purports to measure. A summary of the above will be included in section three.

Background of Learning Styles

1.) Development of the Concept

Two terms repeatedly appear in learning styles research: learning style and cognitive style. Even though these terms are used interchangeably, they are not synonymous. Cognitive style denotes the mental process used by an individual as he/she learns a concept, whereas learning style identifies the stimuli most conducive to the effective use of cognitive style. Cognitive style is the narrower of the two terms and learning style is inclusive of cognitive style.

The learning style theory is grounded in the works of Piaget, Allport, Gullford and Thurson. These theorists were concerned primarily with the developmental aspects of individual differences and learning constructs of intelligence (Keefe, 1979).

The concept of cognitive style did not appear until 1930 in the works of Gordon W. Allport. In the early stages of the development of this term, Allport described cognitive style to be a style of behavior, a style of adaptation, a mode of social adaptation and a type of intelligence. It was not until his book published in 1965, Pattern and Growth in Personality, that Allport clearly delineated cognitive style to be the mental process used by an individual to learn (Allport, 1965).

The research conducted by Carlson and Carr in 1938 dealt with visual and oral memory. The findings of this research resulted in the concept that better learning occurred when an individual memorized material in his/her "superior mode". The superior mode evolved to become learning preferences. As cognitive style was recognized, elements of learning style concepts appeared.

Expansion of cognitive style research is seen in the works of Newton James in 1962. At this time James was interested in cognitive style and its effect on factors of achievement. He conducted a study of the differences in learning as measured by achievement on a standardized test between individuals who expressed a personal preference for visual (reading) or oral (lecture) presentation of the material to be learned. The findings of this study were significant because an apparent difference did exist in individual's test scores when a preference for material presentation was noted. When an individual learned material in his or her preference mode the achievement scores were significantly higher than when an individual learned material in his or her non-preference mode. James found no significant difference existed in test scores of individuals where no preference in oral or visual material presentation was indicated (James, 1962).

Herman Witkin conducted similar research at Brooklyn College. His work dealt with field dependent or field independent learners. An individual was identified as a field dependent or independent learner by his or her response to a picture containing a figure and background. If the individual responded to the background he or she was considered a global learner. If the individual responded to the figure he or she was considered an analytical learner (Keefe). Jerome Kogan's research also focused on analytical styles of thinking and problem solving. He expanded the cognitive domain to include reflective and impulsive dimensions of learning. When viewing concepts the reflective individual is analytical in responding to problem solving and the impulsive individual is quick in responding to the problem solving.

The term learning style was used in the 1960's by Frank Riessman. He identified "the style of learning" as "the idiosyncratic style elements in the learning process" (Reissman, p. 448, 1964). Various elements of a learning style identified by Reissman were visual or auditory learning, single mode of learning or flexible use of several modes of learning, extended time or pressure for learning, mobility while learning and temperature of environment while learning.

2.) <u>Distinctions Between Cognitive Style and Learning Style</u>

Cognitive style is the narrow term indicating the mental processes used by an individual to learn, while learning style is the inclusive term identifying the stimuli most conducive to the effective use of one's cognitive style. Learning style indicates an individual's preferred environment for learning through his or her personal cognitive style or habits for processing information to be learned.

Dunn (1989) states that identifying one's learning style is much easier than explaining its existence. Students are affected by their own emotionality, sociological, environmental and physical preferences. These elements of the student's learning style are distinguished from cognitive style, which describes the ways in which the brain processes information. This can be seen in the work of Witken and his field dependent and field independent learners. The field dependent learner uses a global processor and utilizes all information and integrates it to form a concept. The field independent learner, on the other hand, is an analytical processor of information and formulates concepts independent of the field of information received.

Aspects of learning styles are divided into three categories – cognitive, affective and physiological. The cognitive aspect includes the process of decoding, encoding, processing, storage and retrieval of information. It must also be noted that how these aspects are performed must be a consideration. Performance can be randomly, sequentially, concretely or abstractly, or between these two poles, which result in a continuum.

John Dewey notes "an individual is no longer just a particular, a part without meaning save in an inclusive whole, but is a subject, self, a distinctive centre of desire, thinking and aspiration" (1938, p. 216). The complex structure of learning allows for the emergence of individual, unique styles of learning.

Even though learning is continual and developmental, no two individuals grasp reality in the same manner. This is due to the variety of experiences of the individual, the way they are influenced by environmental stimuli and the way they program themselves to transform reality into a learning process. The process is also known as an individual's learning style. A comprehensive definition of learning style was adopted by a national task force, comprised of leading theorists in the filed and sponsored by the National Association of Secondary School Principals. This group defined "learning styles" as the composite of characteristic cognitive, affective and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with and responds to the learning environment (Keefe, 1997).

Included in this comprehensive definition are "cognitive styles" which are intrinsic information-processing patterns that represent a person's typical mode of perceiving, thinking, remembering and problem solving. According to Dunn, Dunn and Price (1979) each individual learns through complex set of reactions to varied stimuli, feelings and previously established thought patterns that tend to be present when an individual learns. The learning process is conceived as environmental, emotional, sociological and physiological. The major premise of how individuals learn, not the skills used in learning, is the foundation for the Learning Style Inventory. It is a comprehensive approach to the identification of how individuals prefer to learn during educational activities in the following areas:

I. ENVIRONMENTAL LEARNING STYLES
- Sound
- Light
- Temperature
- Design

II. EMOTIONALITY LEARNING STYLES

- Motivation
- Persistent
- Responsibility
- Structure

III. SOCIOLOGICAL LEARNING STYLES

- Learning Alone/Peer Oriented
- Learning with Authority Figure Present
- Learning in Several Ways

IV. PHYSIOLOGICAL LEARNING STYLES

- Perceptional Preferences
  1. Auditory
  2. Visual
  3. Tactile
  4. Kinesthetic
- Intake
- Time of Day
  1. Evening/Morning
  2. Late Morning
  3. Afternoon
- Mobility
- Parent Figure Motivated
- Teacher Motivated

The Learning Styles Inventory (LSI) of Dunn, Dunn and Price was designed to get an individual's personal preferences for different elements in twenty-two areas. These are grouped according to the four quadrants mentioned above. Questions concerning each of the quadrants are presented and selected responses tend to reveal highly personalized characteristics that, when combined, represent the way in which an individual learns. The twenty-two areas include the following:

1. Noise Level – Quiet or Sound. Some students need quiet when they are learning, while others notice neither noise nor movement once they begin to concentrate.
2. Light – Low or Bright. Some students work best under very bright lights, while others need dim, indirect or low light to concentrate.
3. Temperature – Cool or Warm. Some students concentrate best when the temperature of the learning environment is warm while others prefer a cool environment.
4. Design – Informal or Formal. Many students concentrate best in a formal environment seated on wooden, steel, or plastic chairs resembling those found in conventional classrooms or kitchens; while other students concentrate best in an informal environment – on a bed, lounge chair, floor or carpeting.
5. Motivation – Unmotivated/Self-Motivated. Self-motivation is the desire to achieve academically to please oneself.

6. Persistence – Not Persistent/Persistent. This element involves a student’s desire either to complete tasks that are begun or to take intermittent “breaks” and to return to the learning assignment or activity later.
7. Responsibility – Not Responsible/Responsible. This element involves student’s desire to do what they think they ought to do.
8. Structure – Does Not Want Structure/Wants Structure. Many students prefer specific directions/guidance and parameters prior to completing an assignment versus the student’s preference for doing an assignment his or her way without explanations, directions, guidance or set parameters.
9. Learning Alone/Peer Oriented – Some students prefer studying alone while others prefer to study with a peer. In the latter situation, discussion and interaction facilitate learning. Some students prefer to study alone but in close proximity to others. It is important to note that the factor analysis of this test does not differentiate among those students who prefer learning with one or with several individuals.
10. Authority Figures Present – Some students feel more comfortable when someone with authority is present.
11. Prefers Learning in Several Ways – This element has alternate meanings. This suggests that students may learn as easily alone as with other people present (peers, authority or combination) or that the students need variety as opposed to routine.

12. Auditory Preference – This perceptual element describes students whose primary learning preference is listening to verbal interaction such as lectures, discussions or recordings.
13. Visual Preferences – This perceptual element describes students whose primary learning preference is to read or observe material to be learned. When these students are questioned, they usually close their eyes and visually recall the information from diagrammatic or printed material.
14. Tactile Preferences – Students with tactile perceptual strengths need to underline as they read, take notes when they listen to a lecture and keep their hands busy, especially if they have low auditory perception.
15. Kinesthetic Preferences – Students with kinesthetic preferences require whole-body movement and/or real life experiences to absorb and to retain materials to be learned. These students learn most easily when they are totally involved in the learning process.
16. Requires Intake – This element describes a student's preference to eat, to drink, to chew or to bite objects while concentrating as opposed to those students whose preference for any type of intake is after studying.
17. Functions Best in Evening/Morning
18. Functions Best in Late Morning
19. Functions Best in Late Afternoon - The time of day preferences deal with student's energy curves. Evening and morning are on a continuum and student's preferences are based on their preference for morning or not

morning. If a student does not prefer morning, then they conversely prefer evening. If a student's energy curve is highest in the late morning (around 10:00 A.M.) they prefer to learn during the late morning. On the other hand, if the student's energy curve is highest in the afternoon, they prefer to learn during the afternoon.

20. Mobility – This element deals with how long a student can remain stationary. Some students need fragmented "breaks" and must move about the instructional environment. Other students can be stationary in the learning environment and remain engaged in the learning task for long periods of time.
21. Parent Figure Motivated – These individuals want to achieve to please their parents/parent figures. They often complete tasks because a family member will be proud of their accomplishments.
22. Teacher Motivated – These individuals want to learn and to complete assignments because their teachers will be pleased with their efforts.

The Learning Styles Inventory (LSI) of Dunn, Dunn and Price is a 104 item comprehensive questionnaire, which measures an individual's learning preference. It is important to note that the initial response of the individual is scored on a five point Likert scale ranging from Strongly Disagree (SD) to Strongly Agree (SA). Thus, it is imperative that the individual be encouraged to give immediate reaction response to each question on the LSI.

When scoring the LSI of Dunn, Dunn and Price a consistency score is derived from the responses to seven pairs of questions that are repeated throughout the Inventory.

Thus, the higher the consistency of the individual's responses the greater the confidence level of interpretation. For the inventory results to be meaningful, the student should have a consistency score of at least 70% which indicates that 70% of the item pairs were in agreement or identical (Price, 1997).

The Learning Styles Inventory (LSI) is the first comprehensive approach to the assessment of an individual's learning style in grades 3 through 12. This instrument is an important element in identifying the conditions under which an individual is most likely to learn, remember and achieve.

Careful analysis of the individual's LSI data identifies those elements that are critical to a student's learning style. This instrument aids in helping to prescribe the type of environment, instructional activities, social groupings and motivating factors that maximize personal achievement.

A Pearson Product Moment Correlation coefficient reliability score of .929 between test and retest was reported in Virostko's research of 1983. This research reaffirms and substantiates Copenhaver's (1979) research findings that stated learning style preferences remain consistent over time (Kirby, p. 72, 1979).

Learning is both reflective and active, verbal and nonverbal, concrete and abstract. The way an individual perceives reality and reacts to it forms a pattern over time. This pattern comes to dominate the way one integrates ideas, skills and information about people and the way one adapts knowledge and forms meaning (Kolb, 1984). To learn successfully, an individual also needs expertise in other learning styles. According to McCarthy, the combination of these styles forms a natural cycle of learning (McCarthy, 1996).

The belief concerning learning styles is that individuals vary considerably in how they learn. Thus individuals possess modality strengths determined by a combination of hereditary and environmental influences. These modality strengths, which translate into preferences to learn and to communicate visually, orally, spatially and tactically are one's learning style (Dunn, Greggs & Olson, 1995). The logic of the above-mentioned thoughts dictates one to conclude that all styles are different but equal and that intelligence and ability are equally but differentially distributed among human beings. But the issue may not be one of ability of students tested but one of how the students learn and relate this learning. Because of the approach to teaching concepts and in turn assessing learned concepts, the results may appear to be that learning was unsuccessful.

The theory of Carl Jung's psychological types representing different ways of adapting to the world and his developmental theory of individualization was one of the theoretical basis for the development of Kolb's Learning Styles Inventory. The Experiential Learning Theory which has historical roots in the works of Kurt Lewin, the philosophical perspective of pragmatism as depicted in John Dewey's works and the cognitive-development processes of Piaget's research all were contributing factors to the creation of the Learning Styles Inventory of David Kolb. The experiential Learning Theory provides a framework of the learning process consistent with how people think, grow and develop intellectually, psychologically and physiologically. This Experiential

Learning Theory is a holistic integrative perspective on learning that combines experience, perception, cognition and behavior.

According to David Kolb, people are thought to learn from experience and the process is conceived as a four-stage cycle (Kolb, 1985). The cycle consists of:

1. Immediate or concrete experience which becomes the basis for:
2. Observations and reflections.
3. These observations and reflections are assimilated and transformed into a concept from which new implications can be drawn.
4. These implications can be tested or form theories thus serving as guides in creating new experiences.

If learners are to be effective, then all four cycles of learning abilities are necessary. They should possess the ability to be involved in the learning process fully and without bias in new experiences (CE); to reflect on and to observe these experiences from many perspectives (RO); to create concepts that integrate their observations into logical concepts or theories (AC); and to use these concepts or theories to make decisions or solve problems (AE).

Upon closer examination of the four stage-learning model it becomes apparent that learning requires abilities that are polar opposites. Learners must continually decide which set of learning abilities to choose in specific learning situations. Everyone uses the four stage learning process at one time or another, but one particular stage is favored over the others, which is due to the individual's experiences.

There are two main dimensions to the learning process, which are consistent to the two major ways individuals learn:

1. How new information is perceived.
2. How new information is processed after it is perceived.

David Kolb combined the above dimensions in 1971 to form learning quadrants that predict an individual's dominant learning style (Kolb, 1985). These quadrants are:

1. **Converger** – This individual processes organized knowledge through hypothetical deductive reasoning and is relatively unemotional and prefers dealing with things rather than people.
2. **Divergent –** This individual is emotional and prefers dealing with people rather than ideas and performs better in situations that generate ideas.
3. **Assimilator** – This individual prefers theories rather than people and excels in inductive reasoning using integrated explanations.
4. **Accommodator –** This individual is a risk taker who relies heavily on people and uses the contingency theory when executing plans or solving problems.

The Learning Style Inventory of David Kolb is a twelve-item questionnaire, which respondents attempt to describe their learning styles by rank ordering four sentence endings.

These sentence endings are a direct correlation to the four learning quadrant poles, which indicate how a person processes and perceives new information. The poles are: Concrete Experience (FEELING)

Reflective Observation (WATCHING)

Abstract Conceptualization (THINKING)

Active Experimentation (DOING)

A variety of learning styles assessment instruments exists for children as well as for adults (Ellis, Fouts, 1997). The categories used in assessment for this study are as follows:

CATEGORY	CHARACTERISTICS	RESEARCHERS
Cognition – Perceiving, Finding Out, Getting Information	Sensing/Intuition	Jung, Myers-Briggs
	Field Dependent/Field Independent	Witkin
	Abstract/Concrete	Gregorc, Kolb and McCarthy
	Visual, Auditory, Kinesthetic, Tactile	Dunn, Dunn and Price
Conceptualization – Thinking, Forming Ideas, Processing, Memory	Extrovert/Introvert	Jung, Myers-Briggs
	Reflective Observation/ Active Experimentation	Kolb & McCarthy
	Random/Sequential	Gregorc
Affect – Feelings, Emotional Response, Motivation, Values, Judgements	Feeler/Thinker	Jung, Myers-Briggs
	Effect of Temperature, Light, Food, Time of Day, Sound, Design	Dunn, Dunn and Price

Student assessments have been in existence for many years. Most of that time, the purposes of schooling were to sort and to classify students. Now the purposes of schooling or education are to support student learning and to enable every student to fulfill his or her potential (Davis, Kappan, 1997). With the advent of learning styles an alignment of student learning and different learning styles can be accomplished to aid student achievement.

Affective aspects of learning style include eight emotional and personality characteristics which are motivation, attention, locus of control, interests, willingness to take risks, persistence, responsibility and sociability. The physiological aspects of learning include sensory perception (modalities), environmental characteristics (noise level, light, temperature, room arrangement, need for food during study and times of day for optimum learning (Cornett, 1983; Dunn, Dunn and Price, 1979). The individual's purpose or intention is also essential to consider in the processing of information. Cornett states that in studying learning styles one should consider all the pieces before assigning each a value.

Since A Nation at Risk, the average mathematics scores of white, black and Hispanic students have increased as reported by the National Assessment of Educational Progress (NAEP). For all 17 year-old students who were tested, white students' scores improved 9 points, black students' scores improved 14 points and Hispanic students' scores improved 15 points.

The achievement gap between white and black students narrowed between 1982 and 1990, but has widened again through the 1990's, to a 27-point difference in 1996. The achievement gap between white and Hispanic students narrowed since 1982, though the change was not statistically significant and a 21-point gap difference remained in 1996 (Forgione, 1999).

The patterns of academic achievement in math vary widely. Data from the eighth grade Third International Mathematics and Science Study (TIMSS), released in November 1996, showed that U.S. eighth grade students scored below the international average in mathematics. Compared with their international counterparts, U.S. fourth grade students performed above the international average of the 26 TIMSS countries. The countries that out-performed U.S. fourth graders were Singapore, Korea, Japan, Hong Kong, the Netherlands, the Czech Republic, Thailand and Austria. There were no significant differences in performance of students and U.S. students in these (6) countries: Slovenia, Ireland, Hungary, Australia, Canada and Israel. The U.S. fourth grade students ranked higher in mathematics test scores than 12 nations. These nations are: Latvia, Scotland, England, Cypress, Norway, New Zealand, Greece, Portugal, Iceland, Iran, Kuwait and Jordan. As one can see, many of the countries that the United States struggles with for economic power produce students whose mathematical achievement surpasses U.S. students.

Third International Mathematics and Science Study (TIMSS) is a fair comparison of achievement for several reasons. First, the test was jointly developed and collaboratively reviewed by all participating countries to ensure questions were representative of importance and focus of all countries. Second, international monitors carefully reviewed nation's adherences to guidelines to ensure certain students were not excluded from the testing process. Due to the strict adherence of guidelines and collaborative test development, the TIMSS scores are a fair comparison of virtually all student's achievement at the appropriate grade levels (National Research Council, 1996).

In the current research of Howard Gardner and other learning style theorists the constructivism theory and its role in the learning of math has been resurrected. This theory deals with abstraction, which is the process by which the mind selects, combines and registers in the memory a collection of items by degrees of experience. The term abstraction is not a new term and has been discussed by theorists for centuries. Just as abstractions is an important element of learning math, so is the reflection of concepts. Reflection is the process of the mind, which integrates the reasoning process resulting from abstraction and applying this reasoning into real world situations of problem solving.

In scientific constructivism accounts of learning, abstraction is the fundamental mental mechanism by which new mathematical knowledge is generated. Reflection, on the other hand, is the conscious process of mentally replaying the experiences, actions, or mental processes and the considerations of how the results are formulated (Wilson and Bennett, 1994).

The results of the scientific constructivism theory are cyclical. Students cycle through phases of action, both physical and mental, reflection and abstraction in such a manner that enables them to integrate related abstractions into sophisticated mental modes of mathematical and logical thinking. Without this cyclical sequence of mental models, students' learning about mathematical symbols is syntactic and totally disconnected from real world situations.

Research has repeatedly shown that rote learning of syntactic rules for manipulating symbols results in a lack of knowledge of problem solving but an astute capability for rote learning of basic mathematical facts. The use of rote learning of math is necessary, but it is essential that personal meaningful manipulation as well as knowledge of procedures integrate to form reasoning of logical critical thinking and problem solving.

If the issue of math coverage and achievement testing of math concepts are aligned, then student's test results will be valid. If, however, the myth of "if mathematics is covered then students will learn it" and teaching to the test are emphasized, then students will not only be unsuccessful in achievement test scores, but also unsuccessful in retaining problem solving skills needed in real life situations.

A lack of understanding of the testing process creates the "teach to the test" phenomena. Because of state mandated testing for math achievement and not teaching mathematical concepts and reasoning by using scientific constructivism theory or understanding how student's learn, many U.S. students are not as successful as other countries, as reported by TIMSS.

Summary

The literature reviewed for this study indicates that the concept of cognitive style evolved from the theory and research dealing with individual differences in learning. As the concept of learning style was refined and clarified, it became evident that the earlier term of cognitive style came to be known as learning style. The three categories of learning styles are cognitive, affective and physiological.

Cognitive style identifies how an individual's learning is received, formulated and retained. The affective domain of learning style deals with the effect of personality traits involved in attention, emotion and valuing. These elements are identified as motivation, persistence, responsibility, structure and sociological. The third realm of learning styles is the physiological domain. This includes the physical elements of learning and the environmental elements.

The environmental elements of learning styles are design, temperature, sound and light. According to research environmental elements of sound, light and temperature have measurable effects on an individual's learning and performance. Shea conducted research dealing with environmental design and its impact on learning and assessment. Shea found that when seventh grade students were tested in an environment that matched their preference for the learning style element of design, they performed better on standardized testing.

CHAPTER III

PROCEDURES FOR COLLECTION AND TREATMENT OF DATA

This chapter contains the following six sections: (a) statement of the problem, (b) selection of sample, (c) research questions, (d) instrumentation, (e) procedures used in collection of data and (f) analysis of data.

Statement of the Problem

The problem of this study was to determine whether learning styles of students affect their scores on the mathematical portion of the Texas Assessment of Academic Skills test (TAAS).

Population

A non-random purposive sampling technique was employed. All fifth grade students at an intermediate school located in north central Texas were considered for this study. Further screening procedures eliminated those students who did not take the TAAS test. After this screening procedure was completed, 500 students were tested for their preferred learning style. Gender, socioeconomic status and family demographics were not controlled.

The fifth grade students were tested in three large groups. These groups were randomly selected. All students were tested at the same time of the day during a three-day interval. Upon completion of the Learning Style Inventory by Dunn, Dunn and Price, students' answer sheets were separated according to the student's ethnicity.

The identification of students' ethnicity was based upon information provided by the parent. This information is managed by the Texas Education Agency, the local school district and students' home campus. This information is available to school personnel.

Research Questions

The two research questions that were addressed relevant to this study are:

1. Is there a positive correlation between fifth grade students' learning styles and their math standardized test scores?
2. Is there a positive correlation between specific sub groups of fifth grade students' learning styles and their math standardized test scores?

Procedures Used in Collection of Data

The Learning Styles Inventory by Dunn, Dunn and Price was administered to 500 fifth grade students. The students were randomly divided into three equal groups. The test administration was over a three-day period and each group was given the test at the same time of the day by the same person. The average time for the completion of the LSI was approximately 30 minutes.

Each student was instructed to fill out the answer sheet using a #2 pencil and placing their full name, age and gender in the appropriate areas. The students were told to respond to the statements using a five point Likert scale ranging from Strongly Agree, to Strongly Disagree. It was imperative to stress that students' initial responses were necessary. It is important to note that many questions in the LSI instrument are highly subjective and relative (Dunn, 1989). That, of course, is precisely why the responses contribute to an understanding of how each 5th grade student learns in ways that are different from his or her peers.

Upon completion of the LSI, students' answer sheets were coded with an identification number, which indicated their ethnicity. It was the purpose of this study to determine if there was a positive correlation between a student's learning style and their scores on a math standardized test within the realm of gender and ethnicity.

Data Analysis

The Pearson Product Moment Correlation coefficient (r) chosen for this study allowed the researcher to examine a relationship between learning style preferences of 5th grade students and their TAAS test scores in mathematics. A Point biserial correlation (r_{pbis}) was also utilized to examine relationships between male and female fifth grade students' learning style preferences and their TAAS test scores in mathematics. This analysis was also used to examine ethnicity groups' learning style preferences and their TAAS test scores in mathematics.

Design of Study

The variables correlated are continuous scores. The standardized math scores of the TAAS test and the learning style preferences of all fifth grade students, Caucasian fifth grade students, Hispanic fifth grade students, Afro-American fifth grade students and male and female fifth grade students yielded scores in continuous form.

The results of the statistical analysis of the learning style preferences of fifth grade students and their relationship to the math TAAS test scores were interpreted and presented in Chapter 4. Chapter 5 provides a summarization of the study, a discussion of the findings, conclusions and recommendations.

Instrumentation

The Learning Style Inventory (LSI) by Dunn, Dunn and Price was designed to survey an individual's personal preferences in twenty-two elements or variables. It is based on factor analysis and is the comprehensive approach to how students prefer to function, learn, concentrate and perform during educational activities in the following areas: Environmental, Emotionality, Sociological and Physical (Appendix A).

One hundred and four questions concerning the elements are presented and responses are provided on a five-point Likert scale from strongly disagree (SD) to strongly agree (SA). These tend to reveal highly personalized characteristics of an individual student's learning preference. The twenty-two elements include the following:

Figure 1

1. Sound – quiet or sound preferred
2. Light – low or bright
3. Temperature – cool or warm
4. Design – informal or formal
5. Motivation – unmotivated/self-motivated
6. Not Persistent/Persistent
7. Irresponsible/Responsible
8. Structure – wants/does not want
9. Prefers Learning Alone/Peer Oriented Learning

10. Prefers Learning with Adults – authority figures present

11. Prefers Learning through Several Ways

12. Auditory Preference – verbal instruction

13. Visual Preference – visual recall

14. Tactile Preference – underline, note taking

15. Kinesthetic Preference – whole body movement

16. Requires Intake – preference for food or drink

17. Functions Best in Evening/Morning

18. Functions Best in Late Morning

19. Functions Best in Afternoon

20. Mobility – moving about

21. Parent Figure Motivated

22. Teacher Motivated

The LSI reports on twenty-two elements based on two to eight items for each element. The standard score scale or T score ranges from 0 to 80 with a mean of 50 and a standard deviation of 10. The standard score or T score was derived by comparing the raw score to the national data base. This shows the student's position in each learning element compared to other students in the same age group. Students with a standard score or T score of 60 or higher have a high preference for that element when they study new material or perform a difficult task, unless the element is on a continuum where below 40 suggests a predisposition to the opposite, as in the case of requires sound (60 or higher) and requires quiet (40 or lower) or early morning (60 or higher) and evening

(40 or lower). Learning alone or with peers is also an element on a continuum and a standard score or T score of 40 or lower indicates a preference for studying alone while a standard score or T score of 60 or higher indicates a high preference for studying with one or more peers. The elements are listed in Appendix B.

Students whose scores fall between 40 and 60 indicate that they do not have a preference and those elements are not critical to their learning styles, but will vary depending on the situation or student's interest in what is being learned.

Few people are affected by all twenty-two elements or variables. Most individuals have between six and eight elements that are important to them. When an element is unimportant to individuals, they are unaware of their reactions to it. When an element is important, most individuals can describe their preferences and dislikes accordingly.

Reliability and Validity Data Concerning

Learning Style Inventory (LSI)

The reliability data reported in the research of Gary Price on the LSI were based on a sample of 1,836 subjects (942 males, 894 females) in grades 1 through 12 tested in Kansas, Michigan, New York, New Jersey, Pennsylvania and Texas (Price, 1977). The Hoyt analysis of variance procedure was used to estimate the reliability for each sub-scale on the LSI. The Hoyt procedure is equivalent to the Kuder-Richardson Formula 20 (Price, 1977).

In this study intercorrelations, preferences, preference change within grades and across grades for male and female reinforce instrument reliability. The test instrument and additional statistical data was received from Price Systems in Lawrence, Kansas. Of critical importance is the fact that several research studies (Price, 1977) demonstrated that:

1. Students can identify their own learning styles.
2. When exposed to a teaching consonant with the ways they believe they learn, students score higher on tests and factual knowledge, have better attitudes and are more efficient than those taught in a manner that is dissonant with their learning styles,
3. It is advantageous to teach and test students in their preferred modalities.

Dr. G. Price reports the reliability analysis for the various elements on the LSI for grades 1 through 12 as follows:

> "…33% were greater than 70, 25% were between .50 and .69, 23% were between .40 and .29 and 10% were less than .29 with only seven items per sub-scale, reliabilities were generally very good considering the small number of items in each sub-scale" (Price p. 68).

Dr. Gary Price conducted research in 1997 to test the reliability and validity of the LSI. The research indicated that 95% (21 out of 22) of the reliabilities are equal or greater than .60 in grades 5 through 12. The areas with the highest reliability are: noise level, light, temperature, designs, motivation, persistence, responsibility, structure, learning alone or peer-oriented learning, authority figures present while learning in several ways, auditory, visual, tactile, kinesthetic preferences, requires intake, functions best in evening or morning, functions best in afternoon, needs mobility, parent figure motivated and teacher motivated.

The 1983 study of J. Virostko was an analysis of the relationships among academic achievement in mathematics and assigned instructional schedules with the learning style time preferences of sixth grade students. This study revealed that class instructional schedules coordinated with an individual's learning time preference was the most significant factor responsible for increasing achievement test scores in mathematics at the .01 level of confidence (Virostko, 1983).

Texas Assessment Of Academic Skills Test (TAAS)

The Texas Assessment of Academic Skills test is a criterion referenced testing program designed to access problem solving and critical thinking. The test was implemented in October 1990. The TAAS test originally assessed academic skills in grades 3, 5, 7, 9 and 11 (exit level). In its current form, the test assesses student achievement at grades 3 through 8 and grade 10 (exit level).

The contractors of the development and piloting of the Texas Assessment of Academic Skills test were the National Computer Systems (NCS), The Psychological Corporation of San Antonio, Texas (TPC), Measurement Incorporated (MI) of Durham, North Carolina and Austin, Texas and the Texas Education Agency (TEA). The items for the Texas Assessment of Academic Skills test were written by experienced item writers who were experts in devising questions for standardized achievement tests and criterion-referenced instruments. The items were submitted to TPC and reviewed through a collaborative effort of testing experts, context experts and former educators. These items were screened for internal bias. The screening checked for fairness regarding the depiction of minority and gender groups, the appropriateness and clarity of language and the artwork. The Texas Education Agency performed a final review of the test items examining content, level of difficulty, appropriateness and potential cultural ethnic or gender bias.

After extensive reviews, the test items were field-tested using actual student responses from representative samples of students across the state of Texas. After the field test, the items were reviewed again by a panel of representatives of education and business community. Items that passed all stages of development, review, field-testing and data review were placed in the item data bank and were eligible for use on future TAAS test forms (Texas Education Agency 1992-1993).

This section provides specific information on the validity and reliability of the Texas Assessment of Academic Skills test. Content validity is whether the test objectives represent what students should be able to do and whether the items, based on these objectives purport to measure the intended behaviors. Construct validity on the other hand, is the extent to which a test can be said to measure a theoretical construct. In the case of the Texas Assessment of Academic Skills test content and construct validity are intertwined. To insure the highest level of content and construct validity the Texas Education Agency formed advisory committees of educators and business representatives to review the test objectives, instructional targets, specifications and test items.

Criterion related validity indicates the relationship between test performance and performance on some other measure. The TAAS test scores have been correlated with other measures in three ways:

- TAAS test scores for all grade levels are correlated with same subject courses. Validity estimates were determined using 12,000 fifth grade students with approximately four months between measures. The Fall of 1992 validity coefficients were .56 for writing, .60 for reading and .60 for mathematics.
- The Fall of 1991 TAAS test scores for grades 4, 8 and exit level were correlated with the same subject test scores from the Spring of 1992 norm-referenced Assessment Program of Texas test (NAPT). Correlation between the two tests range from .56 to .65 for writing, .68 to .74 for reading and .67 to .77 for mathematics.

- The Fall of 1991 TAAS test scores for grade 11 students were correlated with same subject Texas Academic Skills Program test (TASP). This criterion-referenced test is administered statewide to college students. Correlation between scores on the TAAS and TASP tests were .32 for writing, .62 for reading and .75 for mathematics.

Test reliability indicates the consistency of measurement. TAAS test reliabilities are based on internal consistency measures, specifically on the Kuder-Richardson Formula 20. KR-20 reliabilities range from .75 to .94, with most scores in the high .80 and low .90 range.

The Texas Education Agency supports the validity and reliability of the items used on the previous assessment instruments.

CHAPTER IV

RESULTS OF THE STUDY

Introduction

This chapter presents the results of the evaluation procedures utilized to test the hypothesis of this study. These hypotheses were tested by computing the mean scores of each independent variable. The independent variables are the fifth grade students standardized math scores measured by the Texas Assessment of Academic Skills test (TAAS). The students were placed in categories according to their ethnicity and gender as well as in the general category of all fifth grade students. Their math scores were then compared to all fifth grade students within and outside of their categories. The categories are as follows:

All Students

Caucasian Students

Hispanic Students

Afro-American Students

Male Students

Female Students

The dependent variables are the learning styles of the above-mentioned students as indicated by scoring a standard score of above 60, on the Dunn, Dunn and Price Learning Style Inventory. A standard score or T score of 60 or above represents a preference for that particular element or variable of the learning style inventory. A standard score or T score of 40 or below or more represents a low preference for that particular element of the learning style inventory. If standard scores or T scores range between 40 and 60, this indicates that there is no high or low preference for that particular element of the learning style inventory.

The Pearson Product Moment Correlation coefficient (r) and the Point-biserial Correlation coefficient (r_{pbis}) were used to see if a relationship existed between the learning styles of all fifth grade students, of Caucasian fifth grade students, of Hispanic fifth grade students, of Afro-American fifth grade students and of male and female fifth grade students and their standardized math test scores as measured by the Texas Assessment of Academic Skills test. The significance level was set at .05 ($p < .05$).

Two different types of analysis were used for this research study. They included the Pearson Product Moment Correlation coefficient (r) for the bivariate analysis of the math scores correlated to the learning preferences of:

All Students

Caucasian Students

Hispanic Students

Afro-American Students

The Point-biserial Correlation coefficient (r_{pbis}) was utilized for the bivariate analysis of math scores correlated to the learning style preferences of the dichotomous group of male fifth grade students and female fifth grade students. This analysis was also used to compare the scores of fifth grade students across ethnicity groupings. For example, Hispanic fifth grade students' math scores correlated to their learning style preferences were compared to Caucasian fifth grade students' math scores which were correlated to their learning style preferences. This was performed for each ethnicity group and thus allowed the researcher to examine each and every student's response on the Learning Style Inventory.

These correlation coefficient analyses were utilized to establish if trends existed in the relationship between the dependent variable (the fifth grade student's learning style scores) and the independent variable (the fifth grade student's standardized math test scores on the Texas Assessment of Academic Skills test). After the Learning Style Inventory was administered to 500 fifth graders from a North Texas Intermediate School, the fifth grade students' responses were scored and a consistency score was calculated. The calculations of consistency scores were based upon the student's responses to questions that were repeated throughout the inventory. The higher the consistency score, the greater the confidence that can be placed in interpreting the student's responses. For the inventory results to be meaningful the student should have a consistency score of at least 70% or greater, indicating that responses of 70% of the item pairs were in agreement (Dunn, 1981).

Any student whose responses on the learning style inventory were inconsistent (below 70%) was excluded from this study. The only consistent learning style inventory scores that were considered for this study were fifth grade students who took the math portion of the Texas Assessment of Academic Skills test.

The mean and standard deviation for the student's standardized math test scores as measured by the Texas Assessment of Academic Skills began the analysis. The mean and standard deviation were calculated for standardized math scores of all fifth grade students, of Caucasian fifth grade students, of Hispanic fifth grade students, of Afro-American fifth grade students and of male and female fifth grade students within their general categories. The results are displayed in Table I.

TABLE I

Texas Assessment of Academic Skills Test Math Scores

	Mean	Standard Deviation	Number of Students
All Students	85.39	6.67	282
Caucasian Students	86.24	6.21	200
Hispanic Students	81.13	7.45	34
Afro-American Students	83.55	6.84	48
Female Students	84.72	6.75	134
Male Students	87.34	7.23	148

The descriptive statistics for the dependent variable, the learning styles of the fifth grade students, are displayed in Table II. The 22 elements are listed and the means of both the high score ($\geq$ 60) and the low score ($\leq$ 40) are calculated and displayed in the table. It is important to note that only the high scores are the ones used for this study. The high score indicates a preference for the variable or variables that make up the learning style of a student. The fifth grade students learning style responses are categorized by their ethnicity and gender and then have been compared within and across ethnicity and gender.

TABLE II

Descriptive Statistics

STUDENTS												
	ALL		CAUCASIAN		HISPANIC		AFRO-AMERICAN		MALE		FEMALE	
	Mean≥60	Mean≤40	Mean≥60	Mean≤40	Mean≥60	Mean≤40	Mean≥60	Mean≤40	Mean≥60	Mean≤40	Mean≥60	Mean≤40
Sound	80.365 N=44	84.223N=131	85.62 N=34	90.8 N=108	90 N=5	68.83 N=12	83.657 N=9	69.54 N=11	87.76 N=17	78.154 N=82	86.37 N=21	79.065 N=49
Light	82 N=63	85.0917N=92	89.563 N=41	84.628 N=74	77.34 N=6	53.092 N=11	74.258 N=16	85.85 N=7	81.79 N=24	88.347 N=46	82 N=23	80.391 N=46
Temperature	87.37 N=63	84.63 N=71	86.17 N=49	91 N=51	89 N=2	60.613 N=12	79.963 N=12	76 N=8	82 N=35	81.492 N=43	83.25 N=28	79.825 N=28
Design	79.8 N=34	83.87 N=62	83.91 N=28	83.939 N=50	84.66 N=3	83.853 N=6	60.6 N=3	93 N=6	84.36 N=19	87.96 N=28	79.2 N=15	84.08 N=34
Motivation	85.642 N=78	74.236 N=39	58.358 N=87	85.03 N=33	83.36 N=9	83.5 N=2	82.814 N=11	94 N=4	79.75 N=43	72.283 N=25	84.725 N=45	86.859 N=13
Persistence	81.723N=72	79.17 N=39	87.8 N=59	90.23 N=30	69.53 N=2	72.35 N=4	81.6 N=11	59.24 N=5	84 N=50	82.08 N=23	81.937 N=22	61.223 N=14
Responsibility	85.726N=180	83.612 N=26	87.35 N=135	90.736 N=19	81.446 N=18	80 N=3	72.65 N=27	69.966 N=3	80.6 N=86	70.634 N=19	89.367 N=94	97.435 N=7
Structure	81.47 N=133	87.163 N=25	85.63 N=101	88.467 N=20	78.537 N=17	85.3 N=3	71.73 N=15	81.25 N=4	83.2 N=70	86.38 N=13	84.26 N=63	79.63 N=11
Learning Alone/ Peer Oriented	83.249 N=115	97.742 N=39	90.09 N=85	90.693 N=33	79.6 N=10	89.124 N=2	84.264 N=20	92.113 N=4	84.261 N=58	72 N=21	85.663 N=57	96 N=17
Authority Figures Present	80.34 N=106	85.326 N=46	95.66 N=71	82.586 N=42	81.765 N=14	90.131 N=2	76.6 N=21	88.33 N=3	92.64 N=59	81.859 N=26	96.128 N=44	95.21 N=24
Learn in Several Ways	83.578 N=104	86.913 N=34	89.73 N=73	87.532 N=30	76.286 N=14	87.901 N=2	77.45 N=17	77.5 N=2	78.453 N=56	83.465 N=20	77.92 N=48	98.12 N=13
Auditory	84.75 N=39	82.64 N=90	88.142 N=31	81.74 N=70	82 N=3	85.167 N=6	88 N=5	91.164 N=14	87.693 N=17	85.85 N=47	86.951 N=22	83 N=41
Visual	84.4 N=84	82.723 N=81	86.79 N=58	87.44 N=62	86 N=11	45.29 N=7	87.37 N-15	80.17 N=12	86.25 N=48	79.32 N=40	84 N=36	86.02 N=41
Tactile	81.5 N=66	76.24 N=33	87.632 N=53	77.25 N=28	75 N=3	60.17 N=11	77.93 N=10	78.25 N=4	85.963 N=33	77.3 N=20	87.6 N=33	74.6 N=13
Kinesthetic	86.5 N=31	86.05 N=39	89.47 N=23	87.93 N=33	78 N=4	90 N=2	87.63 N=4	73 N=5	86.67 N=18	96.112 N=24	81.592 N=13	75.03 N=14
Intake	85.73 N=115	83.13 N=32	86.12 N=85	93.3 N=27	77.153 N=13	76 N=2	63.58 N=17	65.73 N=4	88.01 N=51	86.6 N=24	81.875 N=6	82.5 N=8
Morning/Eve. Learning	88.93 N=29	70.95 N=96	95.137 N=24	84.88 N=73	84.579 N=2	56.193 N=9	80.67 N=3	90.71 N=14	95.21 N=14	88.68 N=47	94.66 N=15	80.93 N=49
Late Morning Learning	86.56 N=73	84.037 N=62	80.357 N=53	82.199 N=42	94.756 N=8	98.5 N=5	78 N=12	79.86 N=15	89.436 N=37	75.74 N=38	88.54 N=36	89.873 N=23
Afternoon Learning	83.857 N=115	87.76 N=17	94.56 N=82	88.715 N=14	73.54 N=13	91 N=2	60.75 N=20	79.563 N=2	96.983 N=58	96.9 N=11	75.96 N=57	71 N=6
Mobility	90.69 N=99	92.374 N=66	93.916 N=74	83.49 N=53	90.83 N=5	71.562 N=8	92.956 N=20	72.349 N=8	95.465 N=52	95.91 N=35	93.66 N=47	88.23 N=31
Parent Figure Motivated	80.105 N=133	67.893 N=29	80.887 N=97	66.542 N=26	66.163 N=20	85 N=3	71.56 N=16	77 N=2	80.6 N=68	80.27 N=18	87.54 N=65	47.55 N=14
Teacher Motivated	84.579 N=102	77.09 N=31	87.357 N=71	85.932 N=24	70.25 N=12	98 N=2	81.68 N=19	75.03 N=5	76.68 N=48	81.3 N=24	81.57 N=54	99 N=7

Pearson Product Moment Correlation Results

A bivariate analysis using the Pearson Product Moment Correlation coefficient (r) was utilized and this allowed the researcher to seek trends in the relationship between the twenty-two learning style areas as defined in the Dunn, Dunn and Price Learning Style Inventory and the standardized math scores measured by the Texas Assessment of Academic Skills test. Since the gender and ethnicity issue was also explored in this study, the Point Bi-serial Correlation coefficient (r_{pbis}) was also used because of dichcatomus grouping of students.

The dependent variables were the twenty-two learning style areas measured by the Dunn, Dunn and Price Learning Style Inventory. These variables are divided into four major groups, which influence a student's learning style preference. It is important to note that few people are affected by all twenty-two elements or variables. The main groups which include all twenty-two elements of a student's learning style preference are as follows:

ENVIRONMENTAL

1. Noise level of environment
2. Light of environment
3. Temperature of environment
4. Design (either informal/formal) of environment

EMOTIONAL

5. Motivation level of learner
6. Persistence level of learner

7. Responsibility level of learner

8. Structure

SOCIOLOGICAL

9. Learning alone/learning with peers

10. Learning with authority figures present

11. Learning in several ways

PHYSICOLOGICAL

12. Auditory learner

13. Visual learner

14. Tactile learner

15. Kinesthetic learner

16. Learns best in evening/morning

17. Learns best in late morning

18. Learns best in afternoon

19. Requires intake of food/drink while learning

20. Requires mobility while learning

21. Parent Figure Motivated

22. Teacher Motivated

The independent variables were the Texas Assessment of Academic Skills test mathematics scores. They included the standardized mathematics scores of all fifth grade students, of Caucasian fifth grade students, of Hispanic fifth grade students, of Afro-American fifth grade students and of male and female fifth grade students.

The bivariate Pearson Product Moment Correlation (r) summaries are displayed in Table III for the independent variable of mathematics scores and the dependent variables of learning styles preferences of all fifth grade students, of Caucasian fifth grade students, of Hispanic fifth grade students and of Afro-American fifth grade students.

TABLE III

Descriptive Statistics

Learning Style Inventory for:

Learning Style Inventory	**Math Scores All Students N=282**	**Math Scores Caucasian Students N=200**	**Math Scores Hispanic Students N=34**	**Math Scores Afro-American Students N=48**
Persistence Pearson Correlation (r) Significant (2 Tailed)	.156** .009	.247** .000	-.188 .286	.014 .930
Responsibility Pearson Correlation (r) Significant (2Tailed)	.078 .191	.144* .043	-.074 .738	-.025 .876
Teacher Pearson Correlation (r) Significant (2 Tailed)	-.062 .296	-.027 .708	.365* .034	-.001 .997
Temperature Pearson Correlation (r) Significant (2 Tailed)	.026 .663	-.050 .482	.492** .003	-.082 .615
Visual Pearson Correlation (r) Significant (2 Tailed)	.043 .473	.036 .611	.191 .382	-.368** .010
Kinesthetic Pearson Correlation (r) Significant (2 Tailed)	.019 .757	.032 .652	-.128 .560	.311** .031

*** Correlation is significant at the .05 level (2 Tailed)**
**** Correlation is significant at the .01 level (2 Tailed)**

Of the eighty-eight variables on the matrix, forty-seven showed a negative correlation and forty-one showed a positive correlation between the dependent and independent variables. The six correlations that were positive at the .05 level of significance ($p < .05$) or higher were as follows:

- All students' level of "persistence in completing a difficult task or assignment" is in direct relationship with their math test scores.
- Caucasian students' high level of "persistence in completing a difficult task or assignment" is in direct relationship with their math achievement scores.
- Caucasian students' displayed a strong preference for a high level of "responsibility in completing a difficult task or assignment" and this is in direct relationship to their math achievement scores.
- Hispanic students' high desire to do well on assignments were motivated by "pleasing the teacher" and this is in direct relationship to their math achievement scores.
- Hispanic students' preference for a "warm temperature of the learning environment" is in direct relationship to their math test scores.
- Afro-American students' "kinesthetic learning" style preference is in direct relationship to their math test scores.

The Point bi-serial correlations (r_{pbis}) are displayed in Table IV. The dichotomous group of male and female fifth grade students had forty-four variables on the matrix. Thirty-five of the forty-four variables showed a positive correlation between the independent and dependent variables. The fifteen positive correlations at the .05 level of significance ($p < .05$) or higher were as follows:

- Female students' preference for the "formal design of the learning environment" is in direct relationship their math achievement scores.
- Female students' high level of "responsibility in completing a difficult task or assignment" is in direct relationship to their math achievement scores.
- Female students' preference for "food or drink (intake) while learning" is in direct relationship to their math achievement scores.
- Female students' high sense of "self-motivation in doing well in school" is in direct relationship to their math achievement scores.
- Female students' desire to do well in school is motivated by the "need to please their parents" and is in direct relationship to their math achievement scores.
- Female students' desire to do well in school is motivated by the "need to please their teachers" and is in direct relationship to their math achievement scores.
- Female students' desire for "structure of the learning assignment" is in direct relationship to their math achievement scores.
- Female students' preference for "learning a difficult task alone rather than with peers" is in direct relationship to their math achievement scores.
- Male students' preference for "warm temperature of the learning environment" is in direct relationship to their math achievement scores.

- Male students’ high level of “responsibility in completing a difficult task or assignment” is in direct relationship to their math achievement scores.
- Male students’ “self-motivation to do well in school” is in direct relationship to their math achievement scores.
- Male students’ preference or need for “food or drink intake while learning” is in direct relationship to their math achievement scores.
- Male students’ preference for “time of day (late morning)” is in direct relationship to their math achievement scores.
- Male students’ desire to do well in school is “motivated by the need to please their teacher” is in direct relationship to their math achievement scores.
- Male students’ desire to do well in school is “motivated by the need to please their parents” is in direct relationship to their math achievement scores.

TABLE IV

Descriptive Statistics

Learning Style Inventory for:

Learning Style Inventory	**Math Scores Female Students N=134**	**Math Scores Male Students N=148**
Noise Point-biserial coefficients(r_{pbis}) Significant (2 Tailed)	-.240** .002	-.129* .021
Temperature Point-biserial coefficients(r_{pbis}) Significant (2 Tailed)	.078 .162	.142* .011
Design Point-biserial coefficients(r_{pbis}) Significant (2 Tailed)	.117* .036	-.120* .032
Motivation Point-biserial coefficients(r_{pbis}) Significant (2 Tailed)	.274** .000	.185* .001
Responsibility Point-biserial coefficients(r_{pbis}) Significant (2 Tailed)	.132* .049	.156* .005
Intake Point-biserial coefficients(r_{pbis}) Significant (2 Tailed)	.174* .002*	.196** .000
Late Morning Point-biserial coefficients(r_{pbis}) Significant (2 Tailed)	.079 .160	.145** .010
Parent Point-biserial coefficients(r_{pbis}) Significant (2 Tailed)	.156** .005	.113** .044
Teacher Point-biserial coefficients(r_{pbis}) Significant (2 Tailed)	.193** .001	.174** .002
Structure Point-biserial coefficients(r_{pbis}) Significant (2 Tailed)	.203** .000	.019 .734
Alone Point-biserial coefficients(r_{pbis}) Significant (2 Tailed) N	.212** .001 134.00	-.080 .151 148.00

*** Correlation is significant at the .05 level (2 Tailed)**

**** Correlation is significant at the .01 level (2 Tailed)**

The bivariate analysis using the Point biserial correlation coefficient is displayed in Table V. The dichotomous grouping of Caucasian and Afro-American and Caucasians and Hispanics had sixty-six variables on the matrix. There were two correlations positive at the .05 level of significance ($P<.05$).

When comparing Caucasian students' math scores and their learning style preference to Afro-American students' math scores and their learning style preference the following correlations were significant at the .05 level:

- Caucasian students' high level of "persistence in completing a difficult task or assignment" is in direct relationship to their math achievement scores.
- Caucasian students' high level of "responsibility in completing a difficult task or assignment" is in direct relationship to their math achievement scores.
- Afro-American students' preference for "learning kinesthetically" is in direct relationship to their math achievement scores.

When comparing Caucasian students' math scores and their learning style preference to Hispanic students' math scores and their learning style preference the following correlations were significant at the .05 level:

- Hispanic student's desire to do well in school to "please the teacher" was a high motivational factor and is in direct relationship to their math scores.
- Hispanic student's preference for a "warm temperature of the learning environment" is in direct relationship to their math achievement scores.

The statistics from comparing student's scores across their ethnicity were validated and confirmed by the Pearson Product Moment Correlation coefficient analysis of: All fifth grade students', Caucasian fifth grade students', Hispanic fifth grade students' and Afro-American fifth grade students' math achievement scores correlated to their learning style preferences.

This analysis was performed so the researcher could examine and analysis each student whose standard score or T score was 60 or above on the Dunn, Dunn and Price Learning Style Inventory.

TABLE V

Point-biserial Correlation Coefficients

Texas Assessment of Academic Skills Math Test (TAAS) and the Learning Styles Inventory (LSI)

Categories 1 – 22, Standard Score > 60

ENVIRONMENTAL			
TAAS MATH AND ETHNICITY			
LSI CATEGORY		**CAUCASIANS AND AFRO-AMERICANS**	**CAUCASIANS AND HISPANICS**
1	Sound	.008	.014
2	Light	.413	.286
3	Temperature	.078	.083*
4	Design	.119	.091
EMOTIONAL			
5	Motivation	.179	.162
6	Persistence	.112*	.264*
7	Parent Figure Motivated	.237	.312
8	Teacher Figure Motivated	.136	.255*
9	Responsibility	.298*	.260*
SOCIOLOGICAL			
10	Structure of Learning	.317	.262
11	Learning Alone/Peers	.379	.401
12	Authority Figures Present	.316	.315
13	Learning in Several Ways	.166	.036
PHYSICOLOGICAL			
14	Auditory	.318	.300
15	Visual	.411	.329
16	Tactile	.530	.230
17	Kinesthetic	.069*	.011
18	Intake of Food/Drink	.360	.375
19	Evening/Morning Learning	.339	.454
20	Late Morning Learning	.101	.228
21	Afternoon Learning	.301	.338
22	Mobility While Learning	.380	.296

* Correlation is significant at the .05 level

Summary

The information generated by the Pearson Product Moment Correlation coefficient (r) analysis of the standardized math scores of all fifth grade students, of Caucasian fifth grade students, of Hispanic fifth grade students and of Afro-American fifth grade students when correlated to their learning style preferences produced a correlation at the .05 level of significance ($p < .05$) or higher in only six out of the eighty-eight possible variables. These correlations were found and a direct relationship existed between their standardized math scores and their learning style preferences for the following:

- All students displayed a high level of “persistence when completing a difficult task or assignment”.
- Caucasian students displayed a high level of “persistence when completing a difficult task or assignment”.
- Caucasian students displayed a high level of “responsibility when completing a difficult task or assignment”.
- Hispanic students preferred “teacher motivation” as a reason to do well in school..
- Hispanic students preferred a “warm learning environment”.
- Afro-American students preferred “kinesthetic learning”.

When comparing standardized math test scores and learning style preferences for the dichotomous groups of male and female students, Caucasian and Hispanic students, Caucasian and Afro-American students, Hispanic and Afro-American students, the Point biserial Correlation coefficient (r_{pbis}) was utilized to analyze the data. The findings were significant at the .05 level or higher and a direct relationship existed between math achievement scores and learning style preferences in the following areas:

A.) Gender

Female students displayed a preference for:

- A “formal design of the learning environment”.
- A high level of “responsibility in completing a difficult task or assignment”.
- A need for “food and/or drink (intake)” while learning.
- A high sense of “self-motivation when doing a difficult task or assignment”.
- A desire to do well in school “motivated by the need to please their parents”.
- A desire to do well in school “motivated by the need to please their teacher”.
- A desire for “structure of the learning assignment”.
- A need to “learn difficult task alone rather than in a group setting”.

Male students displayed a preference for:

- A “warm temperature of their learning environment”.
- A high level of “responsibility to complete a difficult task or assignment”.
- A desire to do well in school “motivated by the need to please their parents”.
- A desire to do well in school “motivated by the need to please their teacher”.
- A desire to do well in school is “self-motivated”.
- Need for “food and drink while learning”.
- “Late morning learning rather than evening”.

B.) Ethnicity

- Caucasian students displayed a desire for a high level of “persistence” and “responsibility” when completing a difficult task or assignment.
- Hispanic students preferred a need or desire to do well in school to “please their teacher”. They also preferred a “warm temperature of the learning environment”.
- Afro-American students preferred “kinesthetic learning”.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Purpose

The purpose of this study was to provide a correlation of similarities and differences in students' learning styles and their achievement scores in mathematics and to provide information to persons concerned with how students learn and whether learning styles affect their achievement, especially in mathematics. The dependent variables selected for this study were the learning styles of students as measured by the Dunn, Dunn and Price Learning Style Inventory. The Learning Style Inventory reports learning style preferences in the following areas:

I. Environmental

There are four elements of learning preferences in this area. The elements are:

a. Sound in the learning environment
b. Light in the learning environment
c. Temperature of the learning environment
d. Design of the learning environment (formal/informal)

II. Emotional

There are four elements of learning preferences in this area. The elements are:

a. Motivation of the learner (internal) to complete a learning activity
b. Persistence of the learner to complete a learning activity
c. Responsibility of the learner to complete a learning activity
d. Structure of the learning activity – need for parameters

II. Sociological

There are three elements of learning preferences in this area. The elements are:

a. Learning alone or peer oriented learning when learning a difficult subject
b. Authority figure present when learning a difficult subject
c. Learning in several modalities when learning a difficult subject

III. Physiological

There are eleven elements of learning preferences in this area. The elements are:

a. Auditory learning
b. Visual learning
c. Tactile learning
d. Kinesthetic learning
e. Evening or morning learner – learning curve at the peak

f. Late morning learner – learning curve at the peak

g. Afternoon learner – learning curve at the peak

h. Intake of food or drink when learning

i. Mobility when learning

j. Parent figure motivated

k. Teacher motivated

The independent variables were the mathematics achievement test scores of the students in the fifth grade as measured by the Texas Assessment of Academic Skills test administered in the spring of 1999.

The data was analyzed using the bivariate Pearson Product Moment Correlation coefficient (r) for all students and groups of students categorized by ethnicity. The Point-biserial correlation coefficient (r pbis) was used to analyze the data of the dichotomous group of fifth grade students categorized by gender and by a comparison of each ethnic group to one another. The level of significance was set at .05 ($p < .05$) for both forms of the analyzation of data.

Findings

The findings analyzing the data using the Pearson Product Moment Correlation coefficient were as follows:

1. The correlation of all fifth grade students' learning styles and their math achievement as measured by their test scores on the Texas Assessment of Academic Skills test did produce a significant relationship at the .05 level

($p < .05$) and at the .01 level. This relationship existed between the learning preference of all students as displayed in their high level of “persistence to complete a difficult learning task or assignment” and their math achievement scores.

2. A relationship existed at the .05 level of significance between the learning preferences of Caucasian students' high level of “responsibility to complete a difficult learning task or assignment” and their math achievement scores. There was also a relationship that existed at the .01 and .05 level of significance between the Caucasian students' learning preference in the area of a high level of “persistence to complete a difficult learning task or assignment” and their math achievement scores.
3. A relationship existed at the .05 and the .01 level of significance between the Afro-American students' preference to learn “kinesthetically” and their math achievement scores.
4. There was a correlation at the .05 level of significance between the Hispanic students' learning preference or desire to do well in school motivated by the need to “please the teacher” and their math achievement scores. A relationship existed at the .05 level and the .01 level of significance between Hispanic students' learning preference for a “warm temperature of their environment” and their math achievement scores.

The findings analyzing the data using the Point-biserial correlation coefficient were as follows:

1. There was a correlation at the .05 level of significance between female students' learning style preferences and their math achievement scores in the following areas:
   a. Environmental – preference for a “formal design of the learning environment”
   b. Physiological – preference for the “intake of food or drink while learning a difficult task or assignment”
   c. Emotional – displayed a preference for a high level of “responsibility to complete a difficult learning task or assignment”
2. The correlation of female students' learning preferences and their math achievement scores produced a relationship at the .05 level and .01 level of significance in the following areas:
   a. Emotional – preference or desire to do well in school, “motivated by the need to please a parent”
   b. Emotional – preference or desire to do well in school, “motivated by the need to please a teacher”
   c. Emotional – preference or desire to do well in school is “self-motivated”
   d. Emotional – preference or need for “highly structured learning assignments”
   e. Sociological – preference for “learning alone rather than with peers when learning or studying difficult concepts”

3. The correlation of the learning style preferences of male students and their math achievement scores produced a relationship at the .05 level of significance ($p < .05$). The positive relationships existed in the following areas:
   a. Environmental – male students' preference for a "warm temperature of the learning environment"
   b. Emotional – male students' displayed a high level of "responsibility" to complete a difficult task or assignment
   c. Emotional – male students' preference to do well in school is "motivated by the desire to please parents"
4. Relationships existed at the .05 level and the .01 level of significance between male students' learning style preferences and their math achievement scores in the following areas:
   a. Emotional – displayed a high level of "responsibility in completing a learning task or assignment"
   b. Emotional – preference to do well in school is motivated by a desire to "please the teacher".
   c. Physiological – preference for "learning in the late morning rather than evening"
   d. Physiological – preference for "intake of food or drink while learning or completing a difficult task or assignment"

Based upon the above findings concerning learning styles and math achievement research question one and hypothesis one can be addressed and answered. Research question one stated “Is there a correlation between student’s learning styles and their standardized math test scores?”

It can be concluded that a correlation does exist between fifth grade student’s learning styles and their standardized math test scores for all students with the learning style preference of a high level of persistence to complete difficult learning task or assignment and their math achievement scores.

Hypothesis one stated that “There will be no significant differences in the math Texas Assessment of Academic Skills test scores of fifth grade students with different learning styles as measured by Dunn, Dunn and Price Learning Style Inventory.” Based on the analysis of data completed by using the Pearson Product Moment Correlation coefficient (r) on the learning styles of all fifth grade students and their math achievement, hypothesis one and research question one can be rejected and it can be concluded that there was a difference in math achievement scores of all fifth grade students with different learning styles.

Due to the findings in the correlation or relationship analysis utilizing the Pearson Product Moment Correlation coefficient (r) technique research question two and hypothesis two can be addressed. Research question two stated “Is there a correlation between specific sub groups of fifth grade students’ learning styles and their math test scores?” It can be concluded by the research findings that Caucasian fifth grade students’ learning preferences for a high level of “responsibility” and a high level of “persistence in completing learning a difficult task or assignment" had a direct correlation to their math achievement scores. It was also concluded by the research findings that Afro-American fifth grade students' learning styles and their math Texas Assessment of Academic Skills test scores showed significance at the .05 level and the .01 level in their preference to "learn kinesthetically". It should also be noted that an inverse relationship existed at the .01 level in the area of "perception (visual)" preference for learning and the math achievement scores of the Afro-American fifth grade students.

Hispanic students showed a preference for learning in a "warm environment" and a correlation existed between this learning style preference and their math scores at the .05 level and the .01 level of significance. A correlation between Hispanic students' learning style preferences to do well in school motivated by the desire to "please the teacher" and their math achievement scores was significant at the .05 level. Based upon the analysis of data of specific sub groups of fifth grade student's learning styles and their math achievement scores hypothesis two, hypothesis three and hypothesis four can be addressed and therefore rejected. Hypothesis two stated, "There will be no significant differences in the math Texas Assessment of Academic Skills test scores of Hispanic fifth grade students with different learning styles." This can be rejected based upon the above addressed findings. Hypothesis three stated, "There will be no significant differences in the math Texas Assessment of Academic Skills test scores of Afro-American fifth grade students with different learning styles." This hypothesis can also be rejected due to the above stated findings. Also, hypothesis four, which stated, "There will be no significant difference in the math Texas Assessment of Academic Skills test scores of Caucasian fifth grade students with different learning styles," can be rejected due to the findings of the above.

The findings using the Point-biserial Correlation coefficient (r_{pbis}) relationship analysis addressed the fifth research question which stated, "Is there a correlation between male and female fifth grade students' learning styles and their math achievement?" It can be stated that there were nine relationships that existed between female students learning styles and their math achievement. These nine relationships were positive at the .01 or .05 level of significance. There were also seven relationships that existed between male students' learning styles and their standardized math test scores. These relationships were positive and were significant at either the .05 or the .01 level of significance.

Hypothesis five stated that, "There will be no significant difference in the math Texas Assessment of Academic Skills test scores of fifth grade male and female students with different learning styles. It can be stated that this hypothesis can be rejected due to the sixteen positive relationships that existed at the .01 or .05 level of significance for either the male or female students' learning style preferences and their math achievement scores as measured by the Texas Assessment of Academic Skills test.

It must be ascertained that no causal relationship can be concluded from this research study. It cannot be stated that any independent variable caused variations in any dependent variable. This study only showed correlations existed between fifth grade students' learning styles and their math achievement scores.

Conclusion

“Persistence of completing a difficult learning task or assignment” has a positive relationship on all students' math test scores as measured by the Texas Assessment of Academic Skills. This same element of learning preference as well as “responsibility” can also be seen in Caucasian students’ preference and their math achievement scores. Afro-American students show a strong preference for learning “kinesthetically” as Hispanic students show a preference for “temperature of their learning environment”. It can also be concluded that the Hispanic students have a learning style preference for “doing well in school is motivated by the desire to please the teacher”. It is interesting to note that the “noise level of the learning environment” had an inverse relationship on both male and female students' math test scores. “Intake for food or drink”, “responsibility”, “a desire to do well in school motivated by pleasing the teacher”, “a desire to do well in school motivated by pleasing the parent”, or “self-motivation” had a direct relationship on male and female math achievement scores.

Recommendations

The results of the study lead to the recommendations that the information concerning students’ learning style preferences and non-preferences be provided to the teacher. This will allow the students to learn mathematics in the manner most productive to them and thus increase their math achievement scores.

When a student displays a learning style preference that involves the environmental elements, the following recommendations can be made:

- Temperature of the learning environment - If a student shows a preference for a warm learning environment the teacher should provide enclosures, screens and allow the student to wear sweaters or jackets.
- Design of the classroom – A student who shows a preference for a formal design of the classroom environment should be provided with a desk, straight chairs and table or any formal seating that is equated to a conventional classroom.

For a student or students who show a preference involving emotional elements of the learning style, the following recommendations can be made:

- Self-motivation – These students should be encouraged to use self-designed objectives, procedures and evaluations of the lesson. They should also have lessons designed for them that are self-paced and can provide rapid achievement.
- Persistent – These students should be provided with long-term assignments and little supervision or assistance from the teacher.
- Responsibility – The student who possesses a high level of responsibility should be challenged with short-term assignments and gradually increase the length and scope after the assignments are completed successfully. These students should be challenged at their ability level or slightly above it.
- Need for Structure – The instructions of the lesson or project must be precise, objectives stated clearly and in simple form for the student who shows a preference in this learning style. The teacher should list and itemize as many

things as possible, give a specific time requirement, clearly indicate specific tasks and provide the student with the resources needed.

When a student or students show a preference in the sociological elements of the learning style, the following recommendation can be made:

- Learning Alone – The student should be permitted to work alone when the learning task is difficult. The student should be provided an area in the classroom away from peers (when possible).

If a student or students show a learning style preference or preferences involving the physical elements, the following recommendations can be made:

- Kinesthetic – Student or students should have access to a computer when possible so that he or she can carry out the objectives of the lesson through projects and active experiences.
- Intake – These students should be provided frequent opportunities for food or drink whenever possible. They should be permitted to chew gum, or drink water during the lesson when it does not disturb the learning process of others.
- Time of Day – This element is a difficult one to address in the conventional classroom setting, however, the teacher needs to be cognizant of the student's energy curve in learning when assigning homework. These students can be encouraged to take advantage of their late morning strong energy curve by encouraging them to complete their homework in the morning before school.

- Parent Motivated – Establish a work area near the teacher’s desk and praise the student in front of the parent as well as written communication to the parent.
- Teacher Motivated – Include these students in small group instruction where the teacher is involved. Praise these students often and establish a work area in close proximity to the teacher’s desk.

Recommendations for Further Study

The following recommendations are made:

1. Further consideration should be given to finding if correlations exist between student’s learning styles and their standardized math test scores when teacher’s learning styles are matched with their students.
2. A comparable study should be conducted in a true experimental environment.
3. A further study should be conducted to examine if learning style preferences can be altered or enhanced.
4. Further consideration should be given to matching the teacher’s teaching styles to the student’s learning styles.
5. Further testing for learning styles should be conducted at other grade levels.

APPENDIX A

ELEMENTS OF THE LSI

Appendix A

ELEMENTS OF THE LSI

ENVIRONMENTAL

- Sound
- Light
- Temperature
- Design

EMOTIONALITY

- Motivation
- Persistence
- Responsibility
- Need for Structure or Flexibility

SOCIOLOGICAL

- Learning Alone/with Peers
- Learning with Authority Figures Present
- Learning in Several Ways

PHYSICAL

- Perceptual Preference
- Auditory
- Visual
- Tactile
- Kinesthetic
- Intake
- Time of Day
- Mobility
- Parent Figure Motivated
- Teacher Motivated

APPENDIX B

THE TWENTY-TWO ELEMENTS REPORTED ON THE LSI

Appendix B

The Twenty-Two Elements Reported On The LSI

	20 — 30 — 40	50	60 — 70 — 80
1	PREFERS QUIET	NOISE LEVEL (Sound)	PREFERS SOUND PRESENT
2	PREFERS DIM	LIGHT	PREFERS BRIGHT
3	PREFERS COOL	TEMPERATURE	PREFERS WARM
4	PREFERS INFORMAL	DESIGN	PREFERS FORMAL
5	LOW	MOTIVATION	HIGH
6	LOW	PERSISTENCE	HIGH
7	LOW	RESPONSIBLE	HIGH
8	DOES NOT LIKE	STRUCTURE	WANTS
9	PREFERS ALONE	LEARNING ALONE / PEER ORIENTED	PEER ORIENTED
10	DOES NOT WANT PRESENT	AUTHORITY FIGURE PRESENT	WANTS PRESENT
11	DOES NOT LEARN IN	LEARN IN SEVERAL WAYS	PREFERS VARIETY
12	DOES NOT PREFER	AUDITORY	PREFERS
13	DOES NOT PREFER	VISUAL	PREFERS
14	DOES NOT PREFER	TACTILE	PREFERS
15	DOES NOT PREFER	KINESTHETIC	PREFERS
16	DOES NOT PREFER	REQUIRES INTAKE	PREFERS
17	PREFERS EVENING	TIME OF DAY	PREFERS MORNING
18	DOES NOT PREFER	LATE MORNING	PREFERS
19	DOES NOT PREFER	AFTERNOON	PREFERS
20	DOES NOT PREFER	MOBILITY	PREFERS
21	LOW	PARENT MOTIVATED	HIGH
22	LOW	TEACHER MOTIVATED	HIGH

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