To the Graduate Council:

I am submitting herewith a dissertation written by Azar D. Raisazadeh entitled "Relationship Between Personality Type, Learning Style Preference, and Mathematics Achievement in College Developmental Mathematics." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Education.

Donald J. Dessart, Major Professor

We have read this dissertation
and recommend its acceptance:

Accepted for the Council:

Associate Vice Chancellor and
Dean of The Graduate School

RELATIONSHIP BETWEEN PERSONALITY TYPE, LEARNING STYLE PREFERENCE, AND MATHEMATICS ACHIEVEMENT IN COLLEGE DEVELOPMENTAL MATHEMATICS

A Dissertation

Presented for the

Doctor of Education Degree

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by

Azar D. Raiszadeh

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DEDICATION

To my family

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ABSTRACT

Most community colleges have open-door policies, thus allowing the enrollment of underprepared students. They provide remedial courses to prepare those students for college level mathematics. The primary goal of the remedial and developmental courses is to prepare students to perform as well in their first college level course as the students who do not need a developmental course. In other words, the developmental courses are designed to provide students with the competencies necessary for college work

The increasing demand for remedial and developmental mathematics courses, however, may not necessarily be indicative of students' inability to learn mathematics. It might be the result of a mismatch between those students learning style preferences and personality types on one hand and course content, learning environment, and instructional methods on the other.

The primary objective of this research was to investigate the relationship between students' personality types, learning style preferences, and achievement in Intermediate Algebra. As a secondary purpose this relationship was investigated based on gender and race differences. This study was initiated with the purpose of providing mathematics instructors with such information who could then modify their pedagogical strategies in order to enhance their students' learning, if those relationships proved significant.

To achieve the purposes of this study, three instruments were administered to 202 developmental, Intermediate Algebra students at a community college. Two of these instruments the Myers Briggs Type Indicator (MBTI) and the Learning Style Inventory

(LSI), were administered to students two months after the beginning of the semester. The Academic Assessment and Placement Program (AAPP) test was administered at the end of the semester.

Parametric and nonparametric statistics were applied to analyze the collected data. Specific tests that were used included one-way analysis of variance, two-way analysis of variance, Tukey HSD post hoc multiple comparison test, Student-t test, and Chi square test for independence.

Although the study showed no significant relationships between students' learning style preferences and their mathematics achievement, further analysis revealed that students with Tactile preference achieved lower mathematics scores than their Auditory and Visual counterparts. In the same manner, although the study showed no significant relationships between students' personality types and their mathematics achievements in general, it was found that students with Intuition personality type achieved significantly higher mathematics sores than the students with Sensing personality type. These differences, along with indications from previous research, have led this researcher to believe that learning styles and personality types should be further investigated for their possible impact on students' learning.

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CHAPTER I

INTRODUCTION

American education is faced with the prospect of educating individuals with increasingly diverse backgrounds, having varied social and psychological needs and varying levels of academic ability. These students will bring diverse capacities and a wide range of relevant prior knowledge to learning environments. The ways in which students learn become critical to helping ensure that all students have the opportunity to fulfill their educational potential. The traditional instructional method which groups students into highly structured lecture type environments may not be effective, especially for developmental and low achieving students. Instruction will need to accommodate variations among students in terms of individual needs, time required, and processes used to achieve learner outcomes (Corno & Snow, 1986; Good & Brophy, 1986; Dessart, 1989).

Educational reform has been called for in a number of reports throughout the 1980s and 1990s. *A Nation at Risk* (1983) and its recent update (1994) are the most widely known documents that raise concerns about American education. Other reports from various commissions and foundations make it clear that as we move towards the twenty-first century, existing educational practices and policies will not adequately prepare our students to be competitive in an increasingly global economy.

Regarding concerns about mathematics education, the National Research Council in its report, *Everybody Counts*, wrote "Research on learning shows that most students cannot learn mathematics effectively by only listening and imitating; yet most teachers teach mathematics just this way" (1989, p. 6). The National Council of Teachers of Mathematics (NCTM), in the same line, has responded to the call for reform in teaching and learning of mathematics with guidelines for curriculum change and corresponding teaching standards. The NCTM's premise is "...what a student learns depends to a great deal on how he or she has learned it" (1989, p. 5). The documents are based on the proposition that students have differing ways of learning.

In line with all these concerns, a recently identifiable trend in colleges is the increasing number of students in need of remedial and developmental mathematics courses. This indicates a lack of adequate preparation among recent high school graduates, and should be a source of concern for college administrators as well as state legislators. Solutions have been sought to address this concern. Therefore a major area of research attention has recently been devoted to exploring methods of teaching that could improve students' learning at the high school and college levels.

There is a substantial body of evidence that indicates people do not all learn in the same way. Yet teachers often teach all students in the same way, using a teaching style that has proven successful for the teacher in his or her own learning. Indeed, some researchers have argued that many students diagnosed as Learning Disabled (L.D.) are in fact not L.D., but rather mistaught in terms of learning style, i.e., they are artificially handicapped by their learning environment (Brown and Cooper, 1981). In a recent report

by the New York State Curriculum and Assessment Council (1992) it is indicated that we must "develop understandings of ... how to teach and assess in ways that identify and support different learning styles" (p. 19).

Another closely related factor to learning style whose effects on learning has been studied is personality type. Regarding the effect of learner's personality type to his or her learning, Lawrence (1982) states that personality type is crucial in explaining why certain instruction works with some students and not with others. Dunn (1990) reported that "three-fifths of learning style is biologically imposed. Thus, those students with strong preferences for specific learning style conditions/environments/approaches cannot flex; if they could, they would not be failing" (pp. 15-16).

According to a theory of personality typology developed by Carl Jung and expanded by Isabel Myers and Katherine Briggs, each person has an inborn preferred way of perceiving and judging that influences his/her personality and, therefore, learning. Myers (1980) maintains that students will learn more effectively if they are taught in a way congruent with their personality type. Research findings suggest that using knowledge of students' personality types to tailor instruction would facilitate student learning (Myers, 1980; Golay, 1982; Lawrence, 1982; Curry, 1990; McCarthy, 1990; McCaulley & Natter 1980).

Problem

Most community colleges have open-door policies, thus allowing the enrollment of underprepared students. They provide remedial courses to prepare those students for college level mathematics. The primary goal of the remedial and developmental courses is

to prepare students to perform as well in their first college level course as the students who do not need a developmental course. In other words, "the developmental courses are designed to provide students with the competencies necessary for college work" (Chattanooga State Technical Community College Catalog, 1997-1998, p. 78)

The increasing demand for remedial and developmental mathematics courses, however, may not necessarily be indicative of students' inability to learn mathematics. It might be the result of a mismatch between those students learning style preferences and the teachers' dominant teaching styles, or between the students' personality types and course content and instructional methods.

In order to improve the performance of academically and culturally diverse under prepared students, learning style and personality type preferences should be considered. An understanding of how students learn is vital for curriculum improvement (Keefe, 1979; Smith and Renzulli, 1984).

This research will seek to examine the relationship between students' different learning styles and personality types, and their mathematics achievement. The results may prove valuable to mathematics instructors who can then modify their pedagogical strategies in order to enhance their students' learning in mathematics. It may be that having a particular personality type or learning style makes it more difficult, or easier, for a student to learn mathematics. This study will also seek to determine whether students' performance in mathematics is related to a particular learning style or personality type, and if so, how this knowledge would potentially help schools and colleges improve students' mathematics learning.

Purpose

The primary purpose of this study was to investigate the relationship between students' personality type, their learning style preferences, and their achievement in intermediate algebra. As a secondary purpose this relationship was investigated based on gender and race differences.

The following research questions were examined:

1. Are there significant differences among students' achievement scores in intermediate algebra based on their personality types?
2. Are there significant differences among students' achievement scores in intermediate algebra based on their learning style preferences?
3. Is there a significant difference between students' achievement scores in intermediate algebra based on their gender?
4. Is there a significant difference among students' achievement scores in intermediate algebra based on their race?
5. Within each category of learning style preferences, are there significant differences in students' achievement scores in intermediate algebra based on their gender?
6. Within each category of personality type, are there significant differences in Students' achievement scores in intermediate algebra based on their gender?
7. Within each category of learning style preferences, are there significant differences among students' achievement scores in intermediate algebra based on their race?
8. Within each category of personality type, are there significant differences among Students' achievement scores in intermediate algebra based on their race?

9. Is there a significant relationship between students' personality types and their learning style preferences?
10. Is there a significant relationship between students' personality types and their gender?
11. Is there a significant relationship between students' personality types and their race?
12. Is there a significant relationship between students' learning styles and their gender?
13. Is there a significant relationship between students learning styles and their race?

Need for the Study

A preliminary review of the literature indicated that students learning style preferences and their personality types affect their academic performance in some academic programs or courses. In a study by Garvey and Bootman (1984), a significant relationship was reported between the predominant learning style of students and their achievement scores in a pharmaceutical program. In a study of students' performance in Business and Accounting courses, Carthey (1993) reported that direct relationships existed between particular learning styles of students and their academic achievements. Jamison (1994) reported that direct relationship existed between particular personality type as measured by Myers-Briggs Type Indicator and students mathematics achievement in pre-calculus I.

However, limited research has been done that explore the relationship between learning style preferences and academic achievement in algebra, specifically in the

developmental mathematics programs. The literature search also did not yield any studies of relationships between personality types, demographic variables, and academic achievement in developmental mathematics program.

Information about such relationships could be quite valuable in helping instructors become more cognizant of differences in students learning styles and personality types. If significant relationships were found between achievement and any of these variables, instructors could use this information to better advise students and develop more appropriate instructional material and more effective teaching methods to improve students' achievement in developmental mathematics programs.

Knowledge about the ways students receive, process and present information can be a guide in designing learning experiences that match students' learning style preferences. Dunn, Dunn and Price (1979) favor a match between need of the learner and instructional method. Other researchers, e.g., Claxton & Murrell (1988) and Mathews (1991), have found that such matching is specially beneficial for high risk, underprepared college students. They explain that matching reduces stress and frustration resulting in facilitation of learning. Since the developmental mathematics students can be considered, for whatever reason, underprepared college students, they may as well benefit from the matching style approach. This research is an attempt to shed light on this proposition.

Assumptions

The following assumptions underlie this study:

1. Students responded honestly to statements regarding their personality type and learning style preferences.

2. Students have unique learning style preferences and these preferences can be identified and measured by Learning Style Inventory instrument.
3. Students have unique personality type that can be identified by Myers-Briggs Type Indicator instrument.
4. The Myers-Briggs Type Indicator, the Learning Style Inventory, and the Academic Assessment and Placement Program test, respectively, provide valid and reliable measures of the personality type, learning style preferences and mathematics achievement of the students involved in this study.
5. The students identified in each learning style preference category represented a random sample of all students in the same learning style preference category enrolled in Mathematics 081, intermediate algebra, at Chattanooga State Technical Community College.
6. The students identified in each personality type category represented a random sample of all students in the same personality type category enrolled in Mathematics 081, intermediate algebra, at Chattanooga State Technical Community College.

Delimitation

The sample of students involved in this study was chosen from those students enrolled in Mathematics 081, intermediate algebra, during the Spring semester of 1997 on the main campus of Chattanooga State Technical Community College in

Chattanooga Tennessee. Only the data from students who completed the entire course were used.

Limitations

The following limitation underlie this study:

1. The instruments used to determine learning styles and personality types are self-report, paper and pencil measures. They only evaluate what students perceive and are willing to relate about their actual personality and learning style preferences. Thus student responses may differ from objective facts.
2. This study was limited by the reliability and validity of the instruments used to determine personality types, learning style preferences and measure achievement in mathematics.
3. The target population for this study was represented by cluster sampling of all Mathematics 081, intermediate algebra, students enrolled during the Spring semester of 1997 at Chattanooga State Technical Community College.

Definition of Terms

The following are definition of terms used in this study:

a) Terms related to Myers-Briggs Type Indicator:

Myers-Briggs Type Indicator. "Is a self reporting questionnaire designed to make Jung's theory of psychological types understandable and useful in every day life" (Briggs Myers, 1993).

MBTI. Is the acronym for Myers-Briggs Type Indicator.

Extroversion (E). Extroversion refers to individuals who focus their attention on the outer world of people and external events. They receive energy from interaction with people and experiences. They are sociable and expressive. They take initiative in work and relationship. They learn best in situations filled with movement, action and talk. This group prefers to communicate by talking (Briggs Myers, 1993).

Introversion (I). Introversion refers to individuals who focus their attention on their inner world of experiences. They receive energy from their own internal thoughts and feelings. As students, they are private and contained. They are quiet and less active in the classroom and they do not like group discussions. They best learn individually and in a quiet environment. This group prefers to communicate in writing (Briggs Myers, 1993).

Sensing (S). Sensing individuals prefer to take information through their senses (eyes, ears, etc.). They are observant of what goes on around them. They pay attention to details and learn best when they move from the concrete to the abstract in a step-by-step progression (Briggs Myers, 1993).

Intuition (N). This group prefers to take in information by seeing the big picture, focusing on relationship and connections between facts. They do not pay too much attention to details. They are very good at seeing different ways of doing things (Briggs Myers, 1993).

Thinking (T). This group prefers to use thinking in their decision making and tend to look at the logical consequences of a choice or action. They are fair,

reasonable and tough-minded. They use cause-and-effect reasoning in their decision making (Briggs Myers, 1993).

Feeling (F). This group prefers to use feeling in their decision making. They tend to consider what is important to them and to other people. They understand, support and appreciate others. They are tender hearted and guided by personal value (Briggs Myers, 1993).

Judging (J). These are people who prefer to use their judging process in the outer world, and tend to gauge their learning by the completion of tasks. They like to regulate and control life. Their life styles are structured and organized. They love to plan and get things done and they avoid last minute stresses. They love the structured learning environments (Briggs Myers, 1993).

Perceiving (P). These are individuals who prefer to use their perceiving process in the outer world love to live in a flexible and spontaneous way of seeking to experience and understand life. They prefer not to plan, and stay open to experience last minute options. They feel energized by last minute pressures. They prefer open learning environments (Briggs Myers, 1993).

b) Terms related to Learning Style Inventory:

Learning Style. The unique way that an individual interacts with the learning environment is considered to be the individual's learning style (Brown and Cooper, 1981).

Learning Style Inventory. An instrument developed by Brown and Cooper that is used to identify an individual's learning style (Brown and Cooper, 1981).

LSI. Is the acronym for Learning Style Inventory.

Cognitive Style. Refers to the preferred mode of taking in information. It encompasses five areas: Auditory Language, Visual Language, Auditory Numerical, Visual Numerical, and Tactile Concrete (Brown and Cooper, 1981).

Auditory Language. These are individuals who better learn from hearing words spoken. These individuals are more capable of understanding and remembering words or facts through hearing (Brown and Cooper, 1981).

Visual Language. These are individuals who better learn from seeing words in books, on the board, and on charts. They remember and use information better if they have read it (Brown and Cooper, 1981).

Auditory Numerical. These are individuals who learn numbers through hearing and oral explanations. They may remember phone and locker numbers with ease and they can probably work problems in their heads (Brown and Cooper, 1981).

Visual Numerical. These are individuals who learn numbers through seeing and written presentations. They have to see numbers on the board, in a book, or on paper in order to work with them. They are more likely to remember

and understand mathematics facts if they have seen them (Brown and Cooper, 1981).

Tactile Concrete. These are individuals who learn best by experience. The manipulation of materials, along with sight and sound, will make a big difference to them (Brown and Cooper, 1981).

Social Style. Refers to a learner's preference to work alone or in a group. It encompasses Individual Learner and Group Learner (Brown and Cooper, 1981).

Individual Learner. These are individuals who prefer to study alone. They value their own opinions and they think best and remember more when they have learned alone (Brown and Cooper, 1981).

Group learner. These individuals prefer to study at least with one other person. Group interaction increases their learning and later recognition of facts (Brown and Cooper, 1981).

Expressive Style. Refers to the preferred methods of giving out information. It encompasses Oral Expressive and Written Expressive (Brown and Cooper, 1981).

Oral Expressive. These are individuals who are more comfortable to present the information orally. Organizing and putting thoughts on paper may be a slow, tedious task for these individuals (Brown and Cooper, 1981).

Written Expressive. These individuals are more comfortable to present the information in writing. Their thoughts are better organized on paper than when given orally (Brown and Cooper, 1981).

c) Other terms used in this study:

AAPP. Is the acronym for Academic Assessment and Placement Program, which is a test that measures students' ability to solve problems that involve algebraic operations that needs intermediate algebra skills and concepts.

Achievement. Is the acquisition of skills as measured by appropriate test scores.

CSTCC. Is the acronym for Chattanooga State Technical Community College.

Developmental Course. A remedial course designed to prepare students for courses in the regular college curriculum.

Hypotheses

In order to answer the research questions referred to earlier, the following null hypotheses have been tested at the 0.05 level of significance in this study:

H_1: No significant differences exist among students' achievement scores in intermediate algebra based on their personality types, as measured by the MBTI.

H_2: No significant differences exist among students' achievement scores in intermediate algebra based on their learning style preferences as measured by the LSI.

H_3: No significant difference exists between students' achievement scores in intermediate algebra based on their gender.

H_4: No significant difference exists between students' achievement scores in intermediate algebra based on their race.

H_5: No significant difference exists in students' achievement scores in intermediate algebra based on their gender within each category of learning style preferences.

H_6: No significant difference exists in students' achievement scores in intermediate algebra based on their gender within each category of personality types.

H_7: No significant difference exists in students' achievement score in intermediate algebra based on their race within each category of learning style preferences.

H_8: No significant difference exists in students' achievement scores in intermediate algebra based on their race within each category of personality type.

H_9: No significant relationship exists between students' personality types and their learning style preferences.

H_{10}: No significant relationship exists between students' personality types and their gender.

H_{11}: No significant relationship exists between students' personality types and their race.

H_{12}: No significant relationship exists between students' learning style and their gender.

H_{13}: No significant relationship exists between students' learning styles and their race.

Organization of the study

This study is organized into five chapters. **Chapter I** introduces the study and contains the following components: statement of the problem, purpose of the study, need for the study, assumptions, delimitation, limitations, definitions of terms, hypotheses, and organization of the study. **Chapter II** contains a review of the literature related to personality types, learning style preferences, gender and race, as related to students' academic achievement in general and mathematics achievement in particular. **Chapter III** presents the research design and procedures. **Chapter IV** includes an analysis of data organized by hypotheses being tested. **Chapter V** provides a summary of the study, conclusions and recommendations for future research.

CHAPTER II

REVIEW OF RELATED LITERATURE

The purpose of this study is to investigate the relationship between students' personality types, their learning style preferences, their gender, their race, and their achievement in intermediate algebra. The focus of this chapter is on review of the literature as it relates to learning style preferences, personality type indicators, academic achievement, gender, and race. The survey of literature was conducted on the related topics, with the computerized ERIC search for journal articles, a manual search of Dissertation Abstracts International, PsycLIT Index and a survey of World Wide Web (the UnCover database).

Because no single study addresses all the variables that this study does, the literature review will be classified into three main categories: 1) those dealing with learning styles and personality type measurement, 2) those dealing with learning styles and academic achievement, and 3) those dealing with gender, race, and academic achievement. This review of literature is not intended to be an exhaustive search on any related single topic but rather a list of evidence that provides foundation for the present study. In the next section, a brief introduction to the learning style and personality type theories and their respective measurement instruments is presented in order to provide the readers with some background information on these subjects.

Learning Styles and Personality Type Measurement

Learning style has been defined as the internal structures and processes that affect the individual's reception, interpretation, and use of information. It is seen as three interrelated strands: environmental preferences, information reception modes and information processing modes (Brown and Cooper, 1981). According to Claxton and Ralston (1978) individual learning style is described as a unique way that an individual interacts with the learning environment. Learning style is a way in which an individual grasps and transforms knowledge and experiences into meaningful information. Keefe (1982) defines learning styles as "cognitive, affective and psychological traits that serve as relatively stable indicators of how individual learners perceive, interact with and respond to learning environments" (p. v.) As they relate to students, style elements are conditions under which a student is most comfortable and prefers to learn, or factors which must be considered to understand how students process and store information. They refer to cognitive processing, affective or motivational orientations (e.g., locus of control, which refers to students' beliefs regarding the extent of their ability to influence the outcome of their own learning), perceptual modality strengths (which describes learners' tendencies to use different sensory modes to learn new knowledge, e.g., visual/ spatial, auditory/verbal, kinesthetic/psychomotor), and structural and environmental concerns (e.g., room arrangement, noise and light levels, etc.).

The above mentioned definitions and characteristics of learning styles are in line with Cross's explanation of learning styles. According to Cross:

> People see and make sense of the world in different ways. They give their attention to different aspects of the environment; they approach problems with

> different methods for solution; they construct relationships in distinctive patterns; they process information in different but personally consistent ways. Style has a broad influence on many aspects of personality and behavior: perception, memory, problem solving, interests, and even social behaviors and self-concepts. (1996, pp. 115-116).

To gain a better understanding of learning styles, a brief review of the history of development of some learning style models that have been cited in the literature the most often is presented next.

History and Early Research

The history of research on learning styles goes as far back as the 1890's. Educator and psychologist William James identified three different styles of learning: cognitive, conceptual, and affective styles, which he claimed were indicators of how individuals perceive information, gain knowledge, process ideas, store information, respond, judge, and come to know (James, 1984).

James' work became the pillar of a line of research known as modality research that addressed three basic perceptual modalities: 1) visual, 2) auditory, and 3) kinesthetic. These have become common ideas in American education (Hilgersom-Volk, 1987).

The most widely known researcher who continued the work of James was Carl Jung, whose elaboration of psychological types (1921) formed a basis for "cognitive learning style theory" (Keefe, 1982). Jung's significant observation was that across the commonality of human behaviors, there were groups of behaviors which were common to some and not to the others (Jung, 1976). Jung states that persons can perceive the world in two distinct ways (sensing or intuition) and that people use two distinct and contrasting ways to reach conclusions (thinking or feeling). He also describes a person's attitude

toward life as judging or perceiving. Lastly, Jung describes the way persons direct energy as either being outward (extroversion) or inward (introversion). In Jung's scheme, psychological type is descriptive of what is now called learning style or cognitive style (Bischof, 1964).

Based on Jung's theory of psychological types, the mother-daughter team of Catherine C. Briggs and Isabel Briggs Myers started developing a personality type test in 1942, which they called Myers Briggs Type Indicator (MBTI). A commercial version of the MBTI was developed by the Consulting Psychologist Press in 1975 and published for general professional use. The MBTI is a widely used instrument (Myers, 1991), which measures a person's preferences within the dichotomies described by Jung. It contains over 600 items that can be used to examine, among other things, type differences related to academic aptitude and achievement, teaching and learning, and career choice and satisfaction (Myers and Briggs, 1987). As this is one of the instruments used in the present study, a more detailed explanation of the MBTI will be provided in the next section.

Another major contributor to learning style research was Witkin, who is best known for introducing the cognitive style dimension called field-dependence/field-independence. According to Witkin, field dependence relates to individuals who are dependent upon environmental cues in perception and problem solving, while field independence describes individuals who are not reliant upon the environment for external cues. Witkin states that "cognitive style is a potent variable in students' academic choices and vocational preferences; in students' academic development through their school

career; in how students learn and teachers teach; and in how students and teachers interact in the classroom" (Witkin 1973, p. 11).

Witkin's theory has been examined by other researchers. In his 1977 study, Martin concluded that field-independent students tend to function more effectively in a traditional classroom environment while field-dependent students tend to function better in alternative kinds of instructional environments. Examining teaching styles, Garger and Guild (1984) concluded that teachers might be considered field-dependent and field-independent in their personal styles as well. Field-dependent teachers tend to favor personal conversation, employ discussion techniques to engage students, and emphasize rapport with students. Field-independent teachers demonstrate strength in their ability to organize and guide students' learning by focusing on tasks, providing direct information, and maintaining a more structured environment.

Based on Jung and Witkin's work, Bargar and Hoover (1984) identified a number of learning and teaching implications, three of which directly relate to learning preferences and instruction. They claimed that, first, "psychological type may affect students' preferences for instructional alternatives" (p. 60). For example, the intuitive types may prefer more global concepts and more open instructional formats. The sensing type may prefer direct experience, well-defined goals and organized instructions. The thinking types may have a preference for lectures and objective tests; and finally, the feeling types may prefer group activities that require cooperative relationships with others.

The second related implication, according to Bargar and Hoover, is that "psychological type will affect teachers' preferences for instructional alternatives" (p. 61).

Intuitive type instructors tend to focus on concepts rather than facts and be more wide ranging in presentation, while the sensing type instructors tend to emphasize skills, facts, and concrete outcomes through a controlled set of activities. On the other hand, thinking type instructors tend to focus on large group processes and logical structures of activities, while the feeling type instructors tend to emphasize small group activities and give priorities to individualization in assessment and instruction.

The third implication of personality types as claimed by Bargar and Hoover is that "the first approach to students' learning problems should probably be through their strengths" (p. 61). This suggests that the teaching approach be directed towards students' learning strengths and dominant learning preferences (e.g., sensing, intuitive), in particular when students are experiencing difficulty with learning.

Over the past two decades, interest in applying various cognitive function models and their corresponding measurement instruments to educational practices has increased. Described in the following pages are some of the models and instruments that are most current, cited in the literature, and have direct application to teaching and learning in our education system.

Major Learning Styles Models and Instruments

The Myers Briggs Type Indicator (MBTI) has become the most widely used personality measure for non-psychiatric populations (Myers, 1991). The indicator which measures a person's preferences within the dichotomies described by Jung involves four preferences, each having two sides: Extroversion (E) versus Introversion (I) (EI scale); Sensing (S) versus Intuitive (N) (SN scale); Thinking (T) versus Feeling (F) (TF scale);

and Judgment (J) versus Perception (P) (JP scale). Figure 1 presents a brief description of these four preferences.

The clearest explanation of these four preferences, however, is presented by Claudia Melear. According to Melear (1989), the EI scale measures the direction of a person's preference, or energy and interest toward the outer world of persons, actions, and objects (E), or toward the inner world of ideas and concepts (I). The SN scale measures the person's preference toward perceiving the world through the realities of experience taken in by his or her five senses (S), or for perceiving the world by inferred meanings and possibilities (N). The TF scale measures a person's preferences for whether or not she/he relies more on logical order (T), or more on personal values in making judgments (F). Finally, on the JP scale, the preferences are characterized by a person's tendency to desire closure by planning and controlling events (J), or by being flexible, waiting to see what happens and by reacting to events with spontaneity (P) (Melear, p. 34).

Through the analysis of the answers on the MBTI, a type is assessed for the responding individual. There are sixteen possible personality types, each being a combination of four preferences. Each type is identified by four letters, such as "ENFP." The four letters indicate the preferred side of each of the dichotomous preferences, even though both sides of each dichotomy is used by a person at one time or another (Briggs, 1987). Figure 2 represents the diagram of the Myers-Briggs Type Table.

The MBTI has proven to be useful for educational purposes. It has been used with students ranging from junior high school to college and university. According to Myers

Extraversion (E)

Es learn best in situations filled with movement, action, and talk. They prefer to learn theories or facts that connect with their experience, and they will usually come to a more thorough understanding of these theories or facts during group discussions or when working on cooperative projects. Es tend to leap into assignments with little "forethought," relying on trial-and-error rather than anticipation to solve problems.

Introversion (I)

Since Is may be more quiet and less active in the classroom, teachers may feel the need to press them into taking part in group discussions. Such pressure, however, will often only increase their withdrawal. Teachers need to respect their need to think in relative solitude, for that is how they think best. Is will be more willing to share their ideas when given advance notice. This will allow them time to think about how they will become active in the classroom.

Sensory Perception (S)

Ss learn best when they move from the concrete to the abstract in a step-by-step progression. They are thus at home with programmed, modular, or computer-assisted learning. They value knowledge that is practical and want to be precise and accurate in their own work. They tend to excel at memorizing facts.

Intuitive Perception (N)

Ns tend to leap to a conceptual understanding of material and may daydream or act-out during drill work or predominately factual lectures. They value quick flashes of insight but are often careless about details. They tend to excel at imaginative tasks and theoretical topics.

Thinking Judgment (T)

Ts are most motivated when provided with a logical rationale for each project and when teachers acknowledge and respect their competence. They prefer topics that help them to understand systems or cause-and-effect relationships. Their thought is syllogistic and analytic.

Feeling Judgment (J)

Fs are most motivated when given personal encouragement and when shown the human angle of a topic. Fs think to clarify their values and to establish networks of values. Even when their expressions seem syllogistic, they usually evolve from some personally held belief or value.

Judgment (J)

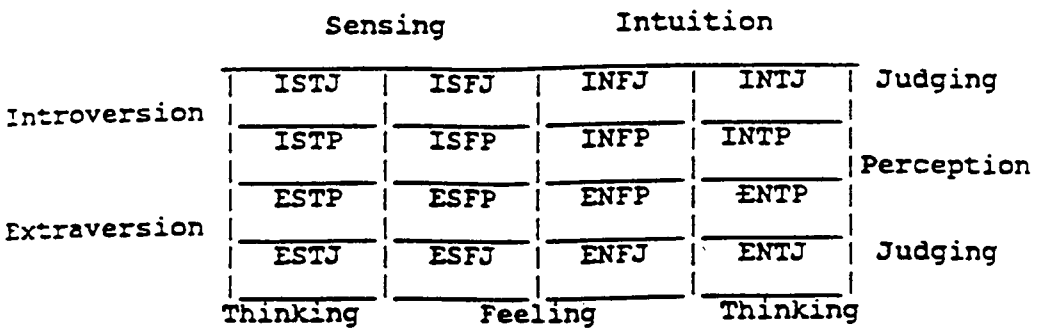
Js tend to gauge their learning by the completion of tasks: reading "x"-amount of books, writing "x"-amount of papers, or making "x"-amount of reports. They thus prefer more structured learning environments that establish goals for them to meet.

Perception (P)

Ps tend to view learning as a free-wheeling, flexible quest. They care less about deadlines and the completion of tasks. They prefer open and spontaneous learning environments and feel "imprisoned" in a highly structured classroom.

Figure 1. Type and Learning Styles (McCauley and Natter (1974)

A. The Sixteen Preference Types on the Type Table



B. Location of the Four Scales Within the Type Table

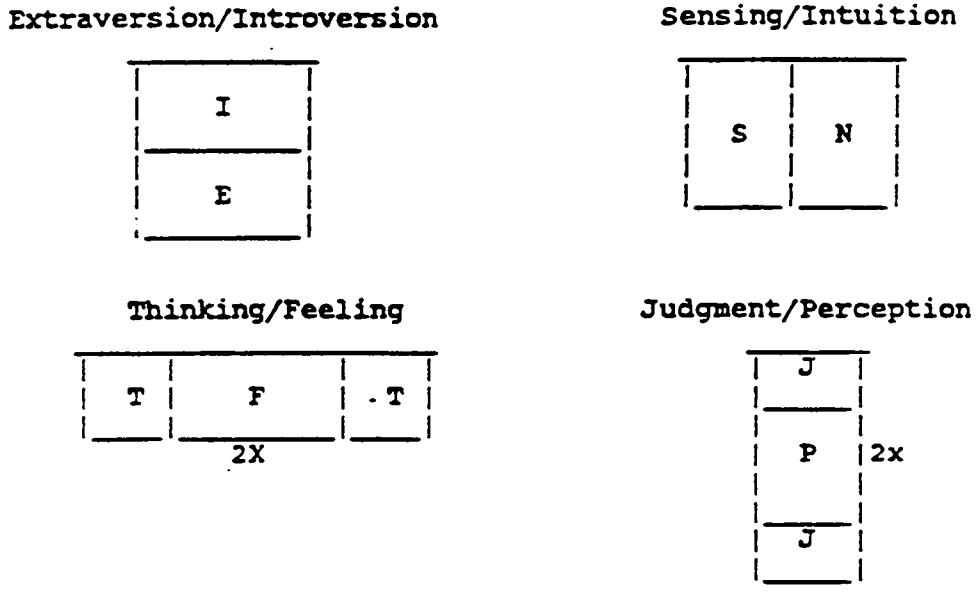


Figure 2. Diagram of the Myers-Briggs Type Table (Gable, 1985)

and Briggs (1987), the MBTI not only identifies types in students, but also helps them to understand their various learning styles (Figure 2). Through the indicator's analysis and explanation of each type, a student can come to know how he/she understands material most effectively -- to know what his/her learning style or personality type is (Myers and Briggs, 1987).

Joseph Hill (1971, 1976) developed a technique called "educational cognitive mapping" to provide students with an understanding of their individual style. In his model, designed to match learners with their learning environments, Hill focused on five instructional methodologies: traditional lecture, individual programmed learning, audio tape, video tape, and group seminars with peer tutoring. The instrument he developed is called the Cognitive Style Interest Inventory. It classifies an individual's educational cognitive style into twenty-seven components. According to Knack (1983), "the idea presented by the Hill prototype--matching student learning styles to instructional methodologies based on an assessment instrument or inventory--is the basis of much of the work done by educational researchers and practitioners during the past decade" (p. 10). Hill's model has been used at a number of vocational-technical institutions across the nation (Knack, 1983).

Learning Style Inventory (LSI) developed by Babich and Randol (1976) was derived from Hill's (1971, 1976) instrument, the Cognitive Style Interest Inventory. The authors selected nine of Hill's twenty-seven constructs, grouped into three areas, for inclusion in their instrument: Cognitive, Social, and Expressive as subdivided into nine

areas (Mental Measurements Yearbook, 1995). The LSI is one of the instruments used in the present study and will be discussed in more detail in a later section.

Another widely used instrument is the Learning Style Inventory (LSI) developed by Kolb (1976). Kolb developed the LSI to describe the ways people learn and ways they deal with ideas and situations. His model is "based on a learning process model--the experiential learning cycle--which resulted from the work of social psychologist Kurt Lewin. This model suggests that learning involves a series of steps beginning with the concrete experience and moving in sequence through reflective observation, abstract conceptualization, and active experimentation" (Knack, 1983, p. 13). Kolb's model identifies four different learning styles: Accommodator, Diverger, Converger, and Assimilator. According to Kolb, Accommodators are best at learning from "hands on" experience (doing and feeling), Divergers excel in using imagination and brainstorming, combining concrete experience and reflective observation (feeling and watching). Convergers' dominant learning abilities are focused on finding practical uses for ideas and theories (doing and thinking). Assimilators are most adept at logically organizing and analyzing information, building and testing theories, and designing experiments.

Rita and Kenneth Dunn (1978) developed a multidimensional model (referred to as Dunn and Dunn model) in which they incorporated affective and psychological as well as cognitive elements of perceptual modality preference. They identified and grouped factors that affect learning in five categories: (a) environment (sound, light, temperature, design), (b) emotional (motivation, persistence, responsibility, structure), (c) social (self, peers, team), (d) physical (perceptual, time, mobility, and intake mechanism for information), and

(e) psychological (global versus analytic, hemisphericity, impulsive versus reflective). The Dunn and Dunn's model is similar in concept to that of Hill in terms of the notion that matching student learning styles to instructional methodology is an effective means of enhancing learning (Dunn and Dunn, 1978).

Gregoric (1982) developed a model that provides for measures of perception and processing of information. His model is based on a promise that we perceive in abstract images at one extreme and concrete images at the other and we then process information sequentially and /or randomly. According to Gregoric, individuals learn in combinations of these four conditions: concrete-sequential; concrete-random; abstract-sequential; and/or abstract-random. This means that we are not necessarily concrete or abstract, nor random or sequential, but rather we use both sets in varying degrees. Individuals do, however, tend to be predisposed to relate best to certain combinations of the four conditions. For example, a concrete-sequential individual tends to need order and predictability in life and relates well to activities which are well-planned, logical and timely, and directed by an experienced person. This individual would not tend to relate as well to a situation dealing with emotions, multifaceted options, and shared decision-making (Gegoric, 1982). Based on further research, Gregoric (1984) maintains that matching the style of teachers and students is appropriate for a period of time, but should not lead to rote learning or boredom for either. Long term mismatching of the styles, on the other hand, is seen as having the potential for more serious adverse effects including major mental, emotional, and even physical problems (Gregoric, 1984).

McCarthy (1980) synthesized the work of learning styles researchers, including Kolb, and integrated their work with that of the leading brain hemispheric researchers[1], producing a model for learning styles and left and right brain modalities. Her model is known as the 4MAT System: Teaching to Learning Styles with Right / Left Mode Techniques. McCarthy explains that "inherent in the 4MAT System are two major premises: (1) people have major learning styles and hemispheric (right-mode / left-mode) processing preferences; and (2) designing and using multiple instructional strategies in a systematic frame work to teach to these preferences can improve teaching and learning" (1990, p. 31). McCarthy's model is intended to be used in an attempt to help students adapt to a variety of learning situations. It is considered by some as a curricular model for teachers' lesson plans (Blair and Judah, 1990).

Learning style theories, including the ones referred to in this section, project the following common themes: (a) the ways different people learn new knowledge are different and their learning style preferences are identifiable, (b) students' awareness of their particular learning styles can be helpful to them in adjusting their environment to their preferred style of learning, (c) matching instructional techniques to learning style preferences of students can have significant impact on students' achievement, and (d) teachers and educational institutions should consider students' learning styles in instructional delivery.

1. Brain hemispheric researchers have found that (1) the two halves of the brain process information differently, (2) both hemispheres are equally important in terms of whole-brain functioning, and (3) individuals rely more on one information processing than the other especially when they approach new learning. Accordingly, they classify learners to left-brained, right-brained, and whole-brained individuals, who receive and process information differently (Bogen, 1975).

It should be noted, however, that there is no consensus over the use of learning styles instruments for teaching/learning purposes. Some learning style researchers believe inventories to diagnose learning styles are necessary to identify styles in order to develop an individualized approach for students in order to increase achievement (Dunn, 1988). Others suggest that students are best served when taught through a variety of approaches and, therefore, inventories may not be necessary (McCarthy, 1980). The middle ground is that learning style inventories allow students and teachers to become aware of their particular styles and preferences and engage in more successful teaching and learning strategies. In particular, teachers must recognize that inventories have limitations in that they are primarily self-reporting instruments, therefore, prone to measurement errors.

The next section of this literature review will summarize specific research based on the major learning styles models related to perceptual modality preferences and matching or mismatching these preferences to the learning environment.

Learning Styles and Academic Achievement

There is a growing body of evidence that people do not learn in the same way (Perry, 1994; Myers & Briggs, 1987; Gregoric, 1982; Brown & Cooper, 1981; McCarthy, 1980; Dunn & Dunn, 1978; Martin, 1977; Kolb, 1976; Witkin, 1973). According to Brown and Cooper, if we require students to receive information in ways that do not correspond with their personal dominant learning modes, or perform under conditions that interfere with their learning, or demonstrate their learning in manners that do not allow them to use their strengths, we create artificial stress, reduce motivation, and repress

performance results. On the other hand, when the teaching/learning environment conforms to style preferences, learning is enhanced (Brown and Cooper, 1981).

Dean (1985) conducted a study to investigate whether a significant relationship existed between individual learning styles and students' performance in a college Basic Programming course. The Inventory of Learning Processes (ILP) and the Purdue Computer, Mathematics, and Science Anxiety Scale (PCMSAS) were the instruments used in this study. These two self-reported questionnaires were administered twice within a period of seven weeks to 138 students. In line with Brown and Cooper 1981 research, the results of this study showed that there was a significant relationship between individuals' unique learning characteristics and their performance in a Basic Computer Programming course.

In order to examine students' and teachers' perceptions of effectiveness of different instructional procedures, Bostick et al. (1988) conducted a study of 860 high school juniors and 60 of their teachers. Respondents were asked to rank fifteen instructional procedures and related classroom activities from most effective for classroom use to least effective. The results of the study showed that there were differences between students' preferences and teachers' preferences in ranking of instructional procedures and related classroom activities. Teachers ranked listening to teacher lecturing as the most effective classroom instructional procedure. However, this method was ranked fourth most effective method by the students. The authors believed the reason for the difference in the ranking of the effectiveness of this method might be attributed to students' style strengths. The traditional lecture method is very effective for teaching

auditory learners, but may be less effective with visual and kinesthetic learners (Barbe and Milone, 1980).

Another interesting finding of this study was that working with computers was selected as the most effective classroom instructional procedure by the students, but was ranked in the sixth position by the teachers. According to the authors, Computer Assisted Instruction can be an effective method of instruction for use with visual and kinesthetic learners or learners with mixed modalities. Referring to Barbe & Milone's (1980) study that indicated that 75 percent of students fall in these three categories, the authors attributed the high ranking that students gave to the effectiveness of computer use to their learning style preferences. Bostick, et al. (1988) concluded that to increase the chances of students' success, teachers should consider the modality strengths of all students and plan instructional activities that teach through student strengths. "When teachers match their teaching strategies to the modality strengths of the students, perhaps there will be less discrepancy between the instructional procedures viewed as most effective by teachers and students" (Bostick, et al., p. 52).

One of the purposes of a study conducted by Melear (1989) was to investigate the relationship between the distribution of psychological types, as measured by the Myers Briggs Type Indicator (MBTI), among non-majors and majors in biology. The MBTI was administered to 600 students in a college level biology course. The purpose of the study was to determine the students' learning styles as a predictor for success in the course. Melear concluded that the psychological types of the non-majors in biology were significantly different from the psychological types of students majoring in biology.

Moreover, psychological types of successful students were different from the psychological types of unsuccessful students. The results of this study indicate that not only students' psychological types affect their choice of major, but also their potential for success.

In a more recent study of the relationship between students' choice of major and their learning style preferences, Perry (1994) administered Kolb's Learning Style Inventory to 86 students in the second year of a Bachelor of Education program in order to identify their learning style distribution. The results of his study indicated that there was a heavy concentration of two learning styles, Abstract Conceptualization and Active Experimentation, as the most commonly preferred learning style for this group of teacher education students. Based on this study, Perry concluded that increasing our knowledge and understanding of the learning styles preferred by our students could provide a rationale for course design as well as a model for the learning process.

Also, in a more comprehensive research, Herbster et al. (1996) conducted a multi-purpose study to determine (a) if there was a relationship between specific learning styles and Myers Briggs Type Indicator preferences; (b) if there was a difference between university students' learning styles and community college students' learning styles; and (c) if teacher education students who have different academic majors have different learning styles. The Teaching and Learning Styles Survey for Adolescents (named TLC), which is based on Jung's style preferences--thinker, feeler, sensor, and intuitor—and the MBTI were administered to 71 community college science students and 119 teacher education students at a four year university. The results indicated that there is a pattern

between different areas of TLC and MBTI. Students who scored highest in the TLC thinker category scored highest in the MBTI Sensing, Thinking, Judging, Introverts category. Students who scored highest in the TLC feeler category scored highest in the MBTI Extrovert, Sensing, Feeling, Judging category. Students scoring highest in the TLC intuitor category scored highest in the MBTI Extroverts, Sensing, Thinking, Judging category. No significant difference was observed between the learning style patterns of community college students and the four-year college students in this study. Regarding students in the teacher education program, the study indicated that students majoring in mathematics and science are more in the thinker categories than the students in other majors like music and English are. Students majoring in social studies scored highest in TLC feelers and in MBTI Extroverts, Feeling, Perceiving category.

The above last three studies are representative of research indicating that (a) there is a relationship between students' personality types and their learning styles preferences, (b) students' dominant learning styles could affect their choice of academic majors, and (c) students' learning style preferences can have significant influence on their academic achievement. These studies suggest that recognition of students' learning styles and personality types and consideration of differing learning styles in curriculum development, instructional delivery, and student advising could lead to students' increased success rate.

Reporting on the result of an experiment applying the Dunn and Dunn learning styles model to mildly handicapped students, Brunner and Majewski (1990) indicated that ever since teachers at Frontier Central High School in Hamburg, New York, began using learning style approach in curriculum development and instruction, the number of special

education students earning a regular high school diploma has grown dramatically. The school's purpose was to improve students' academic achievement by teaching them in ways they learn best and helping them learn new and difficult material at a faster pace and increased retention. The teachers used the Dunn and Dunn's learning style model as input to modify and improve the emotional, psychological, sociological, physical, and environmental elements of the program. They redesigned the physical aspects of their classrooms. For example, to accommodate students' design needs, teachers provided students who required a formal atmosphere with traditional classroom furniture while allowing students who preferred an informal setting to work on a carpeted section of the floor. Also, they paid attention to students' needs for sound, light, and temperature.

The teachers also included sociological elements in their unit plans as well as in their lesson designs. Students who preferred to work individually could do so, while those preferring teamwork were assigned to small groups. Before they began using the new curriculum, only twenty-five percent of their students passed their required local examinations and state competency tests for receiving their diplomas. One year after implementing the new program, the passing rate increased to sixty-six percent, and in the following years it climbed to ninety percent --"a greater ratio of handicapped students passing State Competency exams than regular education students!" (Brunner and Mejewski, p. 22). Although one could attribute the students' increased success rate to their receiving more individual attention from their teachers--the Hawthorne effect--the fact that these mildly handicapped students' success rate had surpassed that of their regular education student counterparts makes it hard not to attribute at least part of their

success to the changes in the curriculum and instructional method based on Dunn and Dunn's model.

Carthey (1994) conducted a study to determine if there was a relationship between students' learning styles and their grade achievements in Principles of Management, Business law, Intermediate Accounting, and Principles of Economics, as well as between the students' brain hemispheric dominance and their academic achievement in these courses. All second-year Accounting students at Northeast Iowa Community College for the years 1988-1991 were the subjects of this study. The McCarthy Hemispheric Mode Indicator (McCarthy, 1986) was used as the instrument for this study. The results showed that there was a direct relationship between the learning style converger (learning style of those who take in experience abstractly and then process what they take in actively) and high academic achievement in Principles of Management, Business law, Intermediate Accounting, and Principles of Economics. In general, there appeared to be an inverse relationship between the learning style diverger (learning style of those who take in experience concretely and then process it actively) and academic achievement of students in the courses that were included in this study. Carthey also observed that left-brained students earned the highest percentage of A's in Principles of Management, Intermediate Accounting, and Principles of Economics. However, students who were whole-brained earned the highest percentage of A's in the Business law course and earned the second greatest percentage of A's in the other three courses studied. Right-brained students earned the lowest percentage of A's in each course under study.

In a study designed to investigate if Myers-Briggs preferences significantly affect students' mathematics achievement, Jamison (1994) administered the MBTI inventory to 175 undergraduate students in a pre-calculus course. She applied the Analysis of Variance technique to the sample data to determine if the MBTI was a significant predictor of the problem solving test scores, algebra skill exam scores, and course grade, i.e., if there were significant relationships between students' learning styles preferences and their performance in those courses. This study showed that the MBTI preference Extroverts versus Introverts (E versus I) was a significant predictor for the problem-solving test. The Judgement versus Perception (J vs. P) preference was a significant predictor for the algebra skills final examination, and both E versus I, and J versus P were predictors for the course grade. Students who were Introverted averaged 8 points higher than Extroverted students on the problem-solving test did. Students who had the Judging preference averaged 11 points higher on the algebra skills final examination and 5 points higher on the course grade over students with Perception preference. The students with the IJ learning style averaged 13 to 20 points higher for scores on the algebra skills final examination and 11 points higher for scores on the course grade than students with the other three learning styles, EP, EJ, and IP.

In a similar study, Williams (1995) used Kolb's Learning Style Inventory in an introductory course in calculus to investigate the relationships between student learning style preferences and their mathematics achievement. An intact group of thirty-two students was selected for the purpose of this study. Mathematics achievement was measured by students' gain scores, as determined by finding the differences between the

post-test scores and pretest scores on a 27-item comprehensive calculus test. One-way Analysis of Variance technique was applied to the sample data to determine whether there were significant differences in the mean calculus achievement gain scores for the four learning style preference groups. This study showed that the relationship of learning style preferences and achievement gain scores was not statistically significant. However, one should be cautious about generalizing the results of this study due to its small sample size ($n = 32$).

A number of researchers have called for further study geared to exploring which factors increase achievement and promote a positive attitude. Research findings do, however, support the theory that matching students' learning style preferences to the learning environment has the potential for increasing successful educational outcomes. These findings raise the question as to whether the students who perform below average in school have learning style preferences that are in conflict with the mode in which they are instructed. This concern also points out to questions about differences in learning and achievement due to students' gender or ethnicity. The next section will look at some studies that have tried to explore these differences.

Gender, Race, and Academic Achievement

Gender and race related academic achievement in general, and mathematics education research in particular, have been plentiful, particularly in the past two decades. Numerous studies have been conducted in an attempt to compare mathematics aptitudes of male and female, and black, white and Hispanic students. In several of such studies, it has been found that boys do better than girls, and whites do better than blacks and

Hispanics in mathematics achievement and participation. Many attempts have been made to explain those differences. No single explanation has been found for these patterns of results, but a number of factors have been identified that might account for these differences. The literature review in this section will be divided into two categories: (a) studies related to gender and race differences in general, and (b) those that have explored these differences in conjunction with learning style preferences of the subjects.

Gender and Race Differences and Academic Achievement

A review of gender and race related literature reveals that the interaction between sex and race roles and mathematics learning has been considered from a number of different perspectives, with the majority focusing on the nature and extent of mathematics achievement of males and females (Lader, 1988). The studies have also focused on various areas of mathematics and a number of different contributing factors. The areas studied have been algebra, proportional reasoning, rote counting skills, computers, and graph comprehension (Jamison, 1994; Stage & Kloosterman, 1995).

Some of the contributing factors identified by researchers in the race and gender studies are: mathematics anxiety, nature and quality of teacher-student interactions, influence of previous course taking, peer group influence, and society and parents' expectations (Stage & Kloosterman, 1995; Moore and Smith, 1987; Fennema & Peterson, 1985; Catsambis, 1994). With regards to race, specifically, other factors such as stereotyping mathematics as a white domain, a lack of understanding of the usefulness of mathematics for postsecondary and career plans, sequence prerequisites for advanced mathematics courses, and the racial composition of the school have been considered

(Jones, Burton, & Davenport, 1984; Mathews et al., 1984). A variety of measures have been used to explore a possible connection between students' mathematics learning and their respective race or gender. It should be noted, however, that not all studies reviewed have reported statistically significant differences in the performance of different groups of students with respect to race and gender.

Moore and Smith (1987) analyzed the scores of mathematics test achievement of 11,914 individuals between ages of 15 and 20 who participated in the National Longitudinal Study of Youth Labor Force Behavior in 1980 in order to examine gender, education, and ethnic group effects. Of the 11,914 sample, 7043 were white, 3028 were black, and 1843 were Hispanic. Of that sample, 5969 were male, and 5945 were female. Their highest grade of education ranged from kindergarten to a college degree. The study results indicated that there were significant education-by-sex interactions. These interactions were due, in part, to higher scores obtained by the female respondents completing grades K to 8 compared to their male counterparts. No significant gender difference was found in the respondents completing grades 9 to 11. However, among respondents who had completed high school or at least some college, the male respondents showed a significant advantage over their female counterparts.

The authors also reported significantly higher performance for whites as compared to Hispanics and blacks at each educational level. However, the difference in favor of the white respondents over Hispanics was greatest at the lowest educational level and the highest educational level. Comparing performance of Hispanics and blacks, the study showed that there was no significant difference for the respondents completing grades K

to 8. The difference in favor of Hispanics was significant for grades 9 through 12. The greatest difference in favor of Hispanics, however, was observed at the highest educational level--respondents with some college education.

Although the performance of all categories of the respondent showed improvement with increased education, large differences in average performance could be seen between ethnic groups with the same amount of formal education. The authors reported that, generally, whites scored higher than Hispanics who scored higher than blacks. In the case of gender differences, the male respondents outperformed their female counterparts except in the lowest level where females outperformed their male counterparts.

Catsambis (1994) used data from a nationally representative sample of eighth grade students who were resurveyed in the tenth grade, to investigate gender and racial-ethnic differences in mathematics participation from middle school to high school. She traced the development of gender differences in learning opportunities, achievement, and choice in mathematics among white, African-American, and Latino students. Her study revealed several significant race and ethnic-specific gender differences in opportunity, achievement, and choice for the eighth and tenth grade students. In terms of opportunities for learning mathematics, this study showed that white female students are exposed to more learning opportunities than male students. However, females lose interest and confidence in mathematics as they get older. Gender differences are the largest among Latinos and the smallest among African Americans. The study also showed that the major barriers to mathematics achievement among minority students of both genders were limited learning opportunities and low level of achievement. According to this study, the

major barriers to mathematics achievement among white female students are attitudes and career choices.

Gender was among many variables that Jamison (1994) examined in order to determine its effect on students' mathematics achievement. In her study of 175 pre-calculus college students, she did not find any significant difference in mean mathematics SAT scores for male versus female students. However, gender differences were noted when successful males and females (students passing the course) were compared. "Females did get higher grades than the males" (p.104). This study also showed that female successful students had significantly higher high school percentile (65.4%) than male successful students (55.3%). Another interesting finding of this study, according to Jamison, was that female college students are still not entering the mathematics, science or business majors at the same rate as the male college students do.

The purpose of the study conducted by Stage and Kloosterman (1995) was to explore relationships between beliefs, gender, and achievement in remedial college-level mathematics. The sample for this study included 236 undergraduate students (95 females and 141 males) in a college remedial algebra course. The Mathematics Skills Assessment Test and the Mathematics Belief Scales (Kloosterman and Stage, 1992) which are respectively designed to measure skills and college students' beliefs about mathematics were instruments for this study. Also, LISREL, a structural equations modeling technique (Joreskog and Sorbom, 1984) was used to explore structural relationships among high school exposure to mathematics, precollege achievement in mathematics, beliefs about mathematics, and final grade in remedial mathematics course.

The findings of this study showed that for female students, high-school mathematics exposure and mathematics skills upon entering college were not significantly related to final grade in the course. The mathematics skills score was related to the arithmetic pretest score and belief scale scores. The final grade was significantly related to arithmetic pretest scores and belief scale scores. For male students, high school exposure to mathematics, scores in mathematics skills assessment, and arithmetic pretest scores were significantly related to final grade. No belief scale scores were significantly related to final grade in the course. For this study, according to the authors, women who had more positive belief about the nature of mathematics and about their own ability were more likely to succeed than women who did not. This study supported Fennema and Peterson's statement that beliefs were more important influences on mathematics achievement for females than they were for males (1985).

Race, Gender and Learning Style Preferences

Men and women are different and so are people of different ethnicity, but do these differences extend to learning styles? Although several researchers have tried to compile a database to clearly address these concerns, there is not yet enough data to answer these questions definitively.

Levy et al., (1972) conducted a study about personality types among black college students. The purpose of the study was to compare personality types of black college students with findings of earlier studies of white college students [these studies were cited from Myers (1962) referring to a study of 3676 white male students from a number of Ivy League colleges, and to a study of 240 white female student from the Pembroke College].

Subjects for the Levy et al.'s study included 758 black undergraduates (311 males, 447 females) enrolled in several undergraduate courses at Howard University. The MBTI was administered in regular class sessions, and additional demographic information was collected from this group. The results of this study showed differences between the black and white students' personality types. Approximately one-fourth of the Howard male sample was categorized as ESTJ, as compared with only 9.3% reported for the "Ivy League" white male students. According to the authors, the reported diversity of types among white students was not matched in the Howard sample where nearly half of the subjects were STJ's (Levy, et al., 1972).

A comparison was also made between data for Howard black female students and Pembroke's white female students. Here too, the researchers found striking ethnic differences. Over one-forth of the black women at Howard were SFJ's, while the major types found among Penbroke white females were NFP's. Explaining why there were so few Intuitive and Perceptive types among black students, the authors suggested that "it seems likely that the experience of living in a 'majority' dominated world, when attention to immediate and concrete details is necessary for both survival and achievement, would impose massive constraints upon the development of 'inmate' preferences for intuitive, perceptive modes of experience" (p. 649).

Results of a few comparative studies of the learning style preferences among students with different cultures suggest that the black students have a tendency to retain and process information through an auditory modality, prefer "hands-on" learning activities, report persistence in learning or a willingness to sustain studying beyond the

required time or until task completion, and prefer formal study arrangements and learn best under cooler temperature. Mexican American students learn better in warm temperatures and under dim light, and they like to move about and take breaks while studying. Native Americans, on the other hand, prefer an informal, relaxed design for studying and require sound to screen against other distractions. They need bright light while learning and prefer spatial tasks. Asian American youth enhance their learning by visual images or graphic representations. They have analytic skills and capacity for identifying complex figures, and would prefer to study during the late morning hours (Jalali, 1989; Griggs and Dunn, 1989; Ewing and Yong, 1992). These findings suggest that educators should be mindful of the fact that learning styles are influenced by cultural differences (Griggs and Dunn, 1989).

The purpose of a study conducted by Dunn et al. (1990) was to determine the effects of hemisphericity (hemispheric preference: successive/simultaneous) and instructional strategies (analytic/global) on minority developmental college students' mathematics achievement, and the relationships between those students' diagnosed hemisphericity and their learning style preferences. A sample of 1104 students enrolled in a developmental mathematics course at New York City Technical Community College were the initial participants for this study. However, because of attrition, between 600 to 800 students actually participated in various phases of the study. The instruments used in this study were (1) the Differential Hemispheric Activation Test (Zenhausern, 1979), (2) Semantic Differential Instrument (McCallon and Brown, 1971), (3) Productivity

Environmental Preference Survey (Dunn & Dunn and Price, 1982), and (4) a number of instructional packages that measure students' mathematics achievement.

Three hundred eighty-seven students showed that they were successive hemispheric processors, indicating that they preferred to learn information presented step by step and sequentially. Two hundred sixty-five students showed simultaneous inclinations -- simultaneous processors are learners who often do not achieve well in school related studies unless they are taught holistically. According to several published reports, the two types learn in diametrically opposed styles and require different instructional material (Dunn & Dunn, 1988; Levy, 1979; Zenhausern, 1980). Thus, according to the authors, approximately 60% of the remedial mathematics students should have been taught by an approach different from that used with their classmates if they were to achieve well when learning difficult material. According to Dunn and Dunn (1988), educators can easily use both simultaneous and successive techniques in their classes once the differences between the two instructional strategies have been demonstrated.

A study was conducted at a large Midwestern university off-campus class site attended almost exclusively by students over the age of 25 --nontraditional students (Sorenson and Robinson, 1992). Demographic data and the MBTI preference scores were collected from the students at the off-campus site. The purpose of the study was to determine whether personality types of nontraditional male and female students differed significantly from each other and from their traditional college student counterparts (based on a sample found in the literature). The findings of the study indicated that personality

types of male and female nontraditional college students were significantly different from the traditional age students, and that there were also significant differences within the nontraditional group between males and females. According to the results of this study, female nontraditional students are more likely than female traditional students to be perception types. Female nontraditional students are more likely to be feeling types while male nontraditional students are more likely to be thinking types. However, the study did not reveal any significant type difference between male nontraditional students and male traditional students.

Simmons and Barrineau (1994) conducted a study to determine whether there is a difference in the learning style of Native American college freshmen compared to their freshman class as a whole at Pembroke State University. The MBTI was used to examine learning preferences of 756 freshmen students including 210 Native Americans. The findings of this study showed that Native American college freshmen had a significantly higher proportion of the Sensing-Feeling learning style and Sensing as preferred perceiving function compared to the entire sample. When gender was considered, Native American males and females showed a significantly higher proportion of Sensing compared to their same sex counterparts in the entire sample. Also, according to the authors, Native American women displayed a significant overrepresentation of Sensing and Sensing-Feeling compared to other females in their college freshman class. Based on this study, and referring to the Macdaid et al. (1987) study (which indicated that the Intuition-Tinkers and Intuition-Feelers accounted for more than 65% of university faculty while Sensing-Feelers accounted for only 14%), Simmoms and Barrineau expressed concern that if such

statistics were true, "the S and SF students may have more professors with learning styles--and by extension, teaching styles-- different from their own" (p. 4). The authors concluded that this mismatch of styles makes the experience of learning much harder for Native American students.

As part of a study to examine the brain-based theory of education (the relationship between brain hemisphere and individual's learning), Allred and Holliday (1995) assessed the learning styles of the students at Fort Mills High School in South Carolina. The investigators used the NASSP Learning Style Profile (LSP) to assess the learning styles of 611 ninth-graders. The NASSP LSP measures student responses on 24 independent scales that relate to study and instructional preferences, perceptual responses, and cognitive skills. The study concluded that 37% of students' achievement could be explained by learning styles preferences. The survey did not find any correlation between learning styles and gender, or learning styles and ethnicity.

Three hundred-ninety-four students in a community college participated in a study conducted by Grimes (1995). The main purpose of the study was to find out if there were differences in learning styles of students in three different risk categories, namely, high-risk students (students with academic difficulties and low GPA's), new students just entering college, and low-risk students (honor students and pre-med majors). The MTS learning style inventory, a 45 item, self-report inventory designed by the Murdock Teacher Center (utilized to assess an individual's preferred style of receiving and processing information) was used to determine the way students receive and process information. According to Grimes, the low-risk students scored higher on English and reading scores and relied less

on auditory language, while the high-risk students depended more on auditory language and less on visual language. The high-risk students showed lower reading and written skills, motivation, concentration, and time management skills.

In this study, female students showed stronger study strategies and a preference for visual mathematics and laboratory. African American students showed no difference in their learning styles when compared to non-minority students. Ethnicity was not found to be a factor in learning and study differences. When GPA was examined, the Asian American students had the highest GPA, followed by Caucasians, then African Americans. Grimes believes that different factors such as heredity, life experiences, and environmental demands determine personality types and learning styles. According to Grimes, students can increase their success by using techniques that match their learning style. Furthermore, when teachers adapt teaching methods to specific learning styles, student achievements, attitudes, and retention would improve (Grimes, 1995).

Philbin et al. (1995) investigated differences in learning styles between males and females. The Kolb Learning Style Inventory, and 12 Educational Dialectical questions (based on a similar set of questions used by Belenky et al., 1986) were administered to 72 subjects of various ethnic groups. Subjects' ages ranged from 21 to 60 and educational levels ranged from high school diploma to doctoral degrees.

The results of the study showed a significant difference in learning styles between the two genders. The study also showed that the issue of "concern for others" was mainly a female response while "concern for self" was primarily a male response. Assimilator learning style, according to this study, is the most preferred learning style for men and the

least preferred learning style for women. The Assimilator learning style reflects traditional education setting. The authors concluded that "traditional education is directed towards and appeals more to males since it is primarily abstract and reflective. Females learn better in hands-on and practical settings emphasizing the realm of the affective and doing" (p. 491). Based on the results of this study, "if females are watching and feeling or doing and thinking, they learn best. If males are thinking and watching, they learn best" (p. 491).

Melear (1995) conducted a study of students' learning styles using MBTI instrument. The focus of her study was female African American students. Two hundred-forty high- school students in science and English classes in four counties in Eastern North Carolina were chosen as the sample for this study. The results of the study showed that African American high school female students are more Sensing than Intuitive and more Thinking than Feeling. Also in this study, a significant number of students showed a preference for Perceiving over Judging. According to the author, this difference suggests that these students prefer a more flexible approach to learning (being able to utilize different settings, e.g., individual learning at times, and group learning at others). Melear indicates that these learning style differences may be one of the many reasons why some African American students are not successful in traditionally structured schools. She suggests that teachers should have an understanding of African American female students who have been viewed as reluctant students because of their behavior (Extroverted and Perceiving). She advises that "Instead of disciplining, we should be encouraging and creating structure for these female students to talk and to participate. This kind of

encouragement can go far to help black girls break the silence they impose on themselves in the classroom" (Melear, p. 76).

Research in gender related differences in mathematics performance has produced mixed results. Numerous studies have reported on observed differences. Many have indicated that such differences are present as early as late childhood but are more clear in older students (Ethington & Wolfe, 1984; Fennema, 1984; Martin & Hoover, 1987). When differences are found, they favor boys, especially in more complex abilities such as problem solving, application of mathematics, and mathematics reasoning. Others have argued that publication bias towards studies in which significant findings are reported has contributed to an exaggeration of gender differences in mathematics achievement. For example, Whitley, et al., reporting on their study of gender differences in attribution for success and failure, concluded "according to our analysis, the achievement attribution made by men and women are really quite similar" (1986, p. 120).

Summary

The literature surveyed gives support to the notion that knowledge of individual learning styles can form a productive basis for curriculum planning, implementation and evaluation. Reckinger (1980) suggests that "teachers should combine the roles of 'farmers' in attending to optimum conditions for students' physical and mental development, and 'artists' in recognizing and respecting their natural talents" (p. 3). Reckinger lists fifty learning style variables in his article, grouping them into environmental, physical, psychological, and mental categories. Keefe (1982) takes the notion of the importance of learning styles even further and suggests that "the concept of

learning styles represents the hope for an authentic individualized education since it starts with the learner and then proceeds logically to a consideration of the teaching and learning environment. An understanding of the ways students learn is the door to educational improvement" (p. 124). It should be noted that, however, researchers have also cautioned against using learning styles on a wholesale basis to cure all educational problems. Dunn, Dunn, & Freeley (1984) indicated that no single learning style element can be isolated and used as the primary means for matching and mismatching learning styles because multiple characteristics influence individual achievement, attitude, and behavior. Therefore, a variety of measures should be considered in determining characteristics of learning style and in determining instructional strategies.

The literature on learning styles and mathematics achievement at the higher education is limited, both in terms of quantity and the ability to generalize from the results. In particular, no specific study was found which would examine the learning style of student taking algebra in college remedial mathematics programs, which is the subject of the present study. However, some of the theoretical and practical applications that are possible using learning styles, particularly related to cognition and the ways students learn and process information, provide support for additional research in the area of mathematics education. In particular, as it relates to the present study, two questions should be addressed: (1) do students in developmental mathematics programs who perform below average have learning style preferences different from those who perform above average, and (2) is there a relationship between these preferences and their achievements?

The next chapter will address the study questions and the hypotheses as part of the research design and methodology.

CHAPTER III

METHODOLOGY

The primary purpose of this study was to investigate the relationship between students' personality types, learning style preferences, and achievement in intermediate algebra. As a secondary purpose, this relationship was investigated based on gender and race comparisons. This study attempted to answer the following research questions based on a sample of community college students enrolled in a developmental intermediate algebra course at Chattanooga State Technical Community College.

1. Are there significant differences among students' achievement scores in Intermediate Algebra based on their personality types?
2. Are there significant differences among students' achievement scores in Intermediate Algebra based on their learning style preferences?
3. Is there a significant difference between students' achievement scores in Intermediate Algebra based on their gender?
4. Is there a significant difference among students' achievement scores in Intermediate Algebra based on their race?
5. Within each category of learning style preferences, are there significant differences among students' achievement scores in Intermediate Algebra based on their gender?
6. Within each category of personality type, are there significant differences in

students' achievement scores in Intermediate Algebra based on their gender?

7. Within each category of learning style preferences, are there significant differences among students' achievement scores in Intermediate Algebra based on their race?
8. Within each category of personality type, are there significant differences among students' achievement scores in Intermediate Algebra based on their race?
9. Is there a significant relationship between students' personality types and their learning style preferences?
10. Is there a significant relationship between students' personality types and their gender?
11. Is there a significant relationship between students' personality types and their race?
12. Is there a significant relationship between students' learning styles and their gender?
13. Is there a significant relationship between students learning styles and their race?

The Setting

Chattanooga State Technical Community College (CSTCC) located in Chattanooga, Tennessee, was the site for this study. CSTCC has an open-door enrollment policy, i.e., any student with a high school diploma or equivalent can be accepted into this college. Many of the entering students do not have the required mathematical background to enroll in the college-level mathematics courses needed for their programs of study. Therefore, the Developmental Mathematics Department was formed to provide those

students with the opportunity --through offering developmental mathematics courses-- to prepare themselves for taking college level mathematics courses.

Developmental Mathematics at CSTCC is a competency-based program of study consisting of three courses, Basic Mathematics (Mathematics 070), Elementary Algebra (Mathematics 080), and Intermediate Algebra (Mathematics 081). The primary goal of the developmental sequence is to prepare the developmental students so that they can perform as well in their first college-level mathematics course as students who do not need to take developmental mathematics courses. According to departmental studies of the students' achievement in the 1996 Fall semester and the 1997 Spring semester, no significant difference in the pass rates in the first college-level mathematics course has been observed between the developmental and non-developmental students enrolled in the course (Developmental Mathematics Department's Reports, Fall of 1996 and Spring of 1997).

Subjects

Students in the Intermediate Algebra classes in the Developmental Study Program at CSTCC were the subjects of this study. Two hundred fifty six students were selected from the 599 students enrolled in the Intermediate Algebra classes in the Spring of 1997, by a cluster sampling method. The selection of the size of the sample was based on the table developed by Krejcie and Morgan (1970). Krejcie and Morgan developed their table for determining sample size based on a formula published by the NEA (National Education Association, 1960), for a significance level of $\alpha = .05$ and an accuracy level of .05. A copy of this table and its corresponding graph is included as Appendix C. According to

this table, the minimum sample size required for this study was 234. However, due to the application of the cluster sampling method, the total number of students sampled was 256. The sample consisted of 112 males (43.75 %) and 144 females (56.25 %). The race distribution for the sample was as follows: 204 (79.7%) Caucasians, 48 (18.8%) African-Americans, and 4 (1.6%) others (three Asians and one Native American). The average student's age was 26.5 years, within a range of 19 to 58.

The researcher did not instruct any classes during the Spring 1997, but she personally administered the survey to all the subjects. The length of the time needed to administer both MBTI and LSI instruments in each class was 50 minutes.

CSTCC was chosen for this study because of availability of subjects to the researcher. Participation in this study was totally voluntary (a copy of the consent form is presented in appendix A.) Participation was encouraged and the results were shared privately with interested participants, upon their request, four weeks after collection of data. A report, which includes the MBTI and LSI output information was shared with the participants (a copy of this report is presented in Appendix D.)

The Course

Intermediate Algebra, Mathematics 081, is the last course of the three-semester developmental mathematics sequence. The method of instruction used in all sections that participated in this study was the traditional format with the instructor as the leader. All instructors in these sections covered the same content, and all students received the same assignments. Application of group activities was encouraged in all sections, as it is in all developmental courses (a copy of the calendar showing the schedule of coverage is

presented in Appendix B.) The same traditional algebra developmental textbook (Developmental Mathematics, fourth edition, 1996, by Bittinger and Beecher) was used in all sections. This textbook covers a three-semester developmental mathematics sequence: basic mathematics, elementary algebra, and intermediate algebra. Covered in the intermediate algebra segment --which was the subject of this study—were several topics: Polynomials, Factoring, Rational Expression and Equations, System of Equations, Radical Expressions and Equations, and Quadratic Equations. A list of topics covered in this course is included in Appendix B.

Students were required to have a Texas Instrument 82 (TI-82) graphic calculator. They were strongly encouraged to use the calculator to explore alternative methods for solving problems and understanding concepts and sketches of graphs and to reduce the exertion associated with arithmetic calculations. This relatively advanced calculator integrates the use of numerical, graphical, and algebraic techniques. All instructors were encouraged to use overhead models for demonstrating the use of the TI-82 calculator.

Mathematics 081, Intermediate Algebra, is a five credit hour course. Each class meets for a total of 4 hours and 10 minutes per week, for fifteen weeks in each semester. CSTCC offers day, night, and weekend classes for this course. The sections included in this study were randomly selected from all sections offered. A copy of the schedule of course offerings for the Mathematics 081 in Spring of 1997 is presented in Appendix B.

Instruments

Several instruments have been used in this study: Myers-Briggs Type Indicator (MBTI), which measures personality type; Learning Style Inventory (LSI), which

measures learning style preferences; and Academic Assessment and Placement Program (AAPP), which measures academic achievement. One copy each of the MBTI and LSI instruments are presented in appendix A. Because AAPP is a secured test, copies cannot be attached; however, a copy of the content material involved in this test is presented in Appendix A. In addition to the use of these instruments, demographic data about the subjects was collected from the students' records.

The MBTI was selected because of its high level of reliability and validity as reported in the literature (Curry, 1987, 1990, and Myers & McCaulley, 1985). Since the researcher was using CSTCC as the setting of this study, and since the LSI has been the learning style inventory used by CSTCC for the past several years, the researcher chose to use the same inventory for this research so that the findings of the study can be a potential source of feedback for CSTCC for future application of this instrument. Finally, the AAPP was used not only because of its high level of reliability and validity (MAPs, 1985), but also due to the fact that it is being used by CSTCC and many other Tennessee colleges, therefore, making this study more relevant to Tennessee.

Myers-Briggs Type Indicator

As it was explained in chapter two, the MBTI is an instrument, which can be used to identify the basic preferences of people in regards to perception and judgment. These preferences comprise four categories and are the basis for identifying personality types. According to the authors of the *MBTI Manual*, "The object of the MBTI is to ascertain, as correctly as possible, the four categories to which the respondent naturally belongs" (Myers and McCaulley, 1985).

The MBTI is published in three forms --Form F, Form G, and Form AV. Form AV is the abbreviated Version and includes the first 50 items from form G and is designed for group situations (e.g., workshops). Form F has 166 items including a number of research items, which were designed to provide data to the MBTI developers for their ongoing MBTI research. Form G was developed in the late 1970's and now is the standard form of the MBTI. This form was used in this study and was administered to the 256 Intermediate Algebra students in the sample. Form G consists of 126 questions or word pairs in three parts with multiple choice answers. Parts I and III consist of 26 and 55 questions, respectively, with the respondent marking the answer that is closest to how he or she usually feels, or prefers. To get an idea as to the types of questions asked in parts I and III, two sample questions are presented below.

14. Does the idea of making a list of what you should get done over a weekend

    A. appeal to you, or

    B. leave you cold, or

    C. positively depress you?

72. Would you say you,

    A. get more enthusiastic about things than the average person, or

    B. get less excited about things than the average person?

Part II consists of 45 questions asking about the respondent's preferences on a dichotomous basis. Examples of the word pairs presented in part II are shown below.

"Which word in each pair appeals to you more?"

27. A. scheduled B. unplanned

61. A. build B. invent

Since the main objective of the MBTI is to identify four basic preferences, the indices E versus I (Extrovert vs. Introvert), S versus N (Sensing vs. Intuitive), T versus F (Thinking vs. Feeling), and J versus P (Judging vs. perception) are designed to point in one direction or the other. (For more information on these dichotomies the reader is referred to chapter 1, pp. 9-11). All choices to the questions reflect the two poles of the sample preference. As a result, one of the sixteen possible combinations of those categories is identified as the respondent's personality type. These types are as follows: ESTJ, ESFJ, ENFJ, ENTJ, ESTP, ESFP, ENFP, ENTP, ISTP, ISFP, INFP, INTP, INTJ, INFJ, ISFJ, and ISTJ (see Figure 2 in chapter 2.)

Scoring for each preference is done by placing the appropriate template on the OpScan sheets of the answers. As an example, persons with a higher total of points for E than for I are identified as Extroverts. In the same manner, the scores are computed and directions are identified for each preference.

The MBTI has been extensively tested for its validity and reliability. Curry (1983) reviewed 21 models of learning style for psychometric acceptability. The MBTI was one of ten found to demonstrate sufficient reliability and validity based on evidence of meaningful data collection, reported and described validity, and reliability of the measure proposed. In 1990, Curry extended her work with a review of learning style instruments and their use in secondary schools. After extensive review, MBTI was identified as one of

thirteen of the strongest available learning style theories based on clarity of definitions, measurements of reliability and validity, and identification of the most relevant characteristics in learners and instructional settings.

According to Curry, the internal split-half reliability was reported in the .80 - .86 range and test-retest in the .70 - .83 range. Internal consistency reliabilities for continuous scores estimated by coefficient alpha and Pearson's r for a sample of high school students ranged from .64 to .83 (Curry, 1990). Moreover, the internal consistency derived from product-moment correlation with continuous scores, with Spearman-Brown Prophecy formula correction, for traditional college students is .82 for E versus I, .81 for S versus N, .82 for I versus F, and .86 for J versus P preferences (Myers & McCaulley, 1985).

In term of construct validity, the MBTI correlates with many other personality tests indicating support for the constructs (Curry, 1987, 1990). Evidence of construct validity from correlation studies comparing the MBTI scores with other instruments' scores shows results that appear to be consistent with Jungian theory. For an extensive review of the validity and reliability of the MBTI, the reader is referred to the *MBTI Manual* (Myers and McCaulley, 1985).

Learning Style Inventory

The LSI was developed by Babich and Randol in 1976, at the Murdock Teacher Center, Wichita, Kansas, as part of an ESEA (Elementary and Secondary Education Act) project. A computerized version of this inventory, used in this study, was developed by Brown and Cooper (1981). The original inventory was derived from Hill's model. The

authors selected 9 of the Hill's 27 constructs grouped into three areas, Cognitive Style, Social Style, and Expressive Style.

Cognitive style refers to the preferred mode of taking in information. This category is divided into five sub-areas: Auditory Language (AL), Visual Language(VL), Auditory Numerical (AN), Visual Numerical (VN), and Tactile Concrete TC). Social Style refers to a learner's preference to work alone or in a group. This category is divided into two sub-areas: Individual Learning (IL) and Group Learning (GL). Expressive Style refers to preferred method of giving out information. This category is also divided into two sub-areas: Oral Expressive (OE) and Written Expressive (WE). The inventory is comprised of forty-five items, in statement form. Five questions are devoted to each of the nine sub-areas. Since the focus of this research was on the investigation of the impact of students' learning styles on their mathematics achievement, the researcher omitted the Auditory Language and Visual Language sub-areas of the LSI for the present study. The remaining sub-areas, in the three categories --(AN, VN, TC), (IL, GL), (OE, WE)-- generated twelve different learning styles, one of which would represent the student's dominant learning style[1].

Students may complete the inventory on a computer, or by pencil and paper. For this study, the LSI instrument was administered by pencil and paper, and data was then

1 In each category, the student's highest total score (out of a maximum of 40), indicated his or her preferred style of learning in that category, leading to the following twelve learning styles: AIO, VIO, TIO, AGO, VGO, TGO, AIW, VIW, TIW, AGW, VGW, AND TGW (the beginning letter of each of the sub-areas was used, e.g., A for Auditory Numerical, V for Visual Numerical, etc.)

inputted into the computer by the researcher for processing. The computerized version of the LSI provides: (1) an individual learning styles graph, (2) a composite graph of the class learning style, (3) a graph matching the individual student's style of learning against that of the class, and (4) a teacher's LSI, so that the teacher can compare his or her style with that of the class composite.

To get an idea as to the types of questions asked, shown below are three sample questions.

9. I understand a mathematics problem that is written down better than one that I hear.

10. I learn best when I study alone.

31. I learn mathematics better from spoken explanations than written ones.

Students respond to each item using a four-point Likert Scale ranging from (1) "least like me" to (4) "most like me." The corresponding scores for responses to questions in each category are added and multiplied by a factor of 2 providing for a maximum of 40 points (5 items times 4 points times 2). If a student's score in any of the nine categories ranges between 34 and 40, that category would indicate the student's dominant learning style. A score between 20 and 32 in any category would indicate the student's minor learning style. A score of 10 to 20 would be too low to identify any learning style for the respondent (Babich and Randol, 1976). The researcher was not able to find any report on the LSI's validity. Limited accounts of its reliability, however, have been cited in the literature. Kevin Crehan, in his evaluation of the LSI, reported that "Median odd-even split-half reliabilities, for the seven sub-scales selected on that basis, range from .64 to .76. Reliabilities for two sub-scales selected on the basis of item-total correlation were not

estimated but, based on the data provided, are probably in the same range. No interscale correlations are reported" (Mental Measurement Yearbook, 1995, p. 569). Crehan also referred to the LSI's content relevant items and ease of administration as positive aspects of this inventory. Also, in his overall evaluation of the LSI, Mark Fugate indicated "...The closest this information may come to a report of reliability is that it provides a sense of the internal consistency within each of the subtopic areas" (Mental Measurement Yearbook, 1995, p.570). The authors of the LSI, Babich and Randol, in their evaluation of the construct reliability of the instrument, reported its split half reliability as follows: "Ninety-five point six percent (95.6%) of the items are greater than .50. Seventy-two percent (72%) of the items are greater than .60, and 31.9% of the items are greater than .70" (Babich and Randol, 1976, p. 4).

Academic Assessment and Placement Program

The Tennessee Board of Regents' AAPP's intermediate algebra skills test was used to measure the students' mathematics achievement. The AAPP may be used in a variety of situations ranging from large-scale screening and placement of entering students to identification of an individual's learning needs, or the comparison of two or more groups of students. It consists of four tests that may be used separately or in any combination. Within each test, questions are organized into clusters designed to give descriptive information about a student's strengths and weaknesses in specific skill areas. The intermediate algebra skills test consists of the following clusters: algebraic operations, solution of equations and inequalities, and coordinate plane and graphs (MAPS, 1985). It consists of 30 multiple choice questions, 10 in each cluster, and is administered in a 30

minutes time frame. Scores for individuals or groups may be compared with the average cluster scores for the varied groups of students tested in the pilot project and reported in MAPS, 1985. The test may also be used to evaluate students' progress over a span of time. The reliability coefficient for the AAPP is reported to be .86 (MAPS, 1985).

Data Analysis

This study is a cross sectional survey. In the cross sectional survey, information is collected at one point in time (Creswell, 1994). A cluster sampling approach was adopted due to its practicality as a means of data collection for this study. This saved the researcher time, and also helped save valuable instruction time, as the data had to be collected during class periods.

The primary statistical procedures used for data analysis involved descriptive statistics, the independent t-test, analysis of variance, and the chi square test of independence. In all cases, a significance level of .05 was used to test the research hypotheses.

Hypotheses 1, 2, 4, 7, and 8 were tested using one-way analysis of variance. Where significant differences were found among the group means, the post hoc test of Tukey HSD was applied to identify the specific means that were significantly different. The t-test was employed to test hypotheses 3, 5, 6, and 7. The chi square test of independence was used to test hypotheses 9, 10, 11, 12, and 13. The SPSS statistical package was utilized to analyze the data. Detailed explanation of the analysis of data and statistical techniques used in this study is presented in the next chapter.

Summary

The primary purpose of this study was to investigate the relationship between students' personality types, their learning style preferences, and their achievement in intermediate algebra. Two hundred fifty-six out of five hundred ninety nine students enrolled in intermediate algebra class at CSTCC during Spring semester of 1997 were involved in this study. Participants were selected by use of cluster sampling method. Three instruments, MBTI, LSI, and AAPP were used to collect data. The MBTI was used to identify students' personality types, the LSI was applied to identify students' learning styles; and the AAPP was used to measure students' mathematics achievement.

Descriptive statistics, analyses of variance, the independent t-test and the chi square test were used to analyze the data. The analysis of the data and corresponding discussions are presented in the next chapter.

CHAPTER IV

RESULTS

The primary purpose of this study was to investigate the relationship between students' personality type, their learning style preference, and their achievement in intermediate algebra. As a secondary purpose this relationship was investigated based on gender and race differences. To collect data three instruments --MBTI, LSI, and AAPP-- were administered to the student subjects. In addition to the use of these instruments, demographic data about the subjects were collected from the students' records.

The primary statistical procedures used to test the hypotheses of this study were descriptive statistics, the independent t-test, parametric analysis of variance, and the Chi square test of independence. When using analysis of variance for testing a hypothesis, where significant differences were found among the group means, the Tukey HSD post hoc test was applied to identify the specific means that were significantly different.

The study began with a sample of 256 students. However, due to attrition, the number of students who took the mathematics achievement test (AAPP) at the end of the semester was 202 hence, the analyses dealing with the students' mathematics achievement was performed with the sample of $n = 202$.

Hypotheses

All thirteen null hypotheses of this study were tested at the 0.05 level of significance. Each hypothesis is presented in this chapter using the same format. The outline begins with a statement of the hypothesis and is followed by the report of overall findings and concluded with corresponding tables.

The SPSS statistical package was used for all statistical analyses. When applying the independent t-test, Levene's test for equality of variances was performed to test the equal variance assumption. By the same token, in applying the analysis of variance technique, the SPSS's built in test of homogeneity of variances was performed for testing the assumption of equality of variances.

H_1: No significant differences exist among students' achievement scores in Intermediate Algebra based on their personality types, as measured by the MBTI.

Students' mathematics achievement was measured by the Intermediate Algebra segment of the AAPP. The overall mean of the Intermediate Algebra test for all sixteen personality type groups (n = 202) was 18.94 with a standard deviation of 4.57. These results are summarized in Table 1. Table 2 presents the descriptive statistics for each of

Table 1
Summary Statistics of the Students' Mathematics Achievement for All Personality Types

	N	Minimum	Maximum	Mean	Std. Deviation
Mathematic Achievement Score	202	8	29	18.94	4.57

Table 2
Descriptive Statistics
Learning Style Preferences and Mathematics Achievement

Personaliy Type		N	Minimum	Maximum	Mean	Std. Deviation
ESTJ	Mathematic Acheivement Score	23	12	26	20.00	4.01
ESTP	Mathematic Acheivement Score	7	15	24	19.57	3.26
ESFJ	Mathematic Acheivement Score	23	9	28	17.57	5.67
ESFP	Mathematic Acheivement Score	13	8	26	17.38	4.75
ENTJ	Mathematic Acheivement Score	6	16	23	19.33	2.50
ENTP	Mathematic Acheivement Score	15	12	26	19.40	4.17
ENFJ	Mathematic Acheivement Score	3	17	21	19.33	2.08
ENFP	Mathematic Acheivement Score	17	12	26	20.00	4.66
ISTJ	Mathematic Acheivement Score	27	10	26	17.37	4.23
ISTP	Mathematic Acheivement Score	18	11	29	18.72	5.40
ISFJ	Mathematic Acheivement Score	19	11	27	18.37	5.00
ISFP	Mathematic Acheivement Score	8	16	26	20.88	3.48
INTJ	Mathematic Acheivement Score	3	14	23	18.67	4.51
INTP	Mathematic Acheivement Score	7	14	27	19.29	4.68
INFJ	Mathematic Acheivement Score	5	19	26	21.00	2.92
INFP	Mathematic Acheivement Score	8	15	27	22.00	4.54

the sixteen personality type groups. As can be seen in Table 2, the INFP type (n = 8) had the highest mean achievement score (22.0) while the ISTJ type (n = 27) had the lowest mean achievement score (17.37).

The parametric one-way analysis of variance was applied to the sample data to determine whether there were significant differences in mean mathematics achievement scores for the sixteen personality type groups that were identified by the MBTI. The mathematics achievement score was the dependent variable and the personality type was the independent variable. As Table 3 indicates, the effect of personality type on mathematics achievement of students was not statistically significant at the alpha level of .05 ($F_{15, 186} = 1.049$, $p = .407$).

Table 3
ANOVA-Personality Type and Achievement

		Sum of Squares	df	Mean Square	F	Sig.
Mathematic Achievement Score	Between Groups	327.945	15	21.863	1.049	.407
	Within Groups	3875.342	186	20.835		
	Total	4203.287	201			

The independent t-test was performed on each of the four categories of preference scales (Extrovert versus Introvert, Sensing versus Intuition, Thinking versus Feeling, and Judging versus Perceiving) in order to find out if there were significant differences in mathematics achievement of students in any of the preference scale categories. Tables 4 through 7 present the results of these tests. No significant differences were observed

Table 4
Extrovert/Introvert and Mathematics Achievement

Group Statistics

	Extrovert/Introvert	N	Mean	Std. Deviation	Std. Error Mean
Mathematic Achievement Score	Extrovert	109	18.95	4.48	.43
	Introvert	93	18.92	4.71	.49

Independent t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Std. Error Difference
Mathematic Achievement Score	Equal variances assumed	.788	.376	.045	200	.964	.65

Table 5
Sensing/Intuition and Mathematics Achievement

Group Statistics

	Sensing/Intuition	N	Mean	Std. Deviation	Std. Error Mean
Mathematic Acheivement Score	Sensing	138	18.47	4.73	.40
	Intuition	64	19.95	4.06	.51

Independent T-test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Mathematic Acheivement Score	Equal variances assumed	2.064	.152	-2.16	200	.032	-1.48	.69
	Equal variances not assumed			-2.29	141.7	.024	-1.48	.65

Table 6
Thinking/Feeling and Mathematics Achievement

Group Statistics

	Thinking/Feeling	N	Mean	Std. Deviation	Std. Error Mean
Mathematic Acheivement Score	Thinking	106	18.88	4.28	.42
	Feeling	96	19.01	4.89	.50

Independent T-test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Mathematic Acheivement Score	Equal variances assumed	2.171	.142	-.206	200	.837	-.13	.65
	Equal variances not assumed			-.205	189.9	.838	-.13	.65

Table 7
Judging/Perceiving and Mathematics Achievement

Group Statistics

	Judging/Perceiving	N	Mean	Std. Deviation	Std. Error Mean
Mathematic Acheivement Score	Judging	110	18.55	4.55	.43
	Perceiving	92	19.41	4.58	.48

Independent T-test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Mathematic Acheivement Score	Equal variances assumed	.298	.586	-1.346	200	.180	-.87	.64
	Equal variances not assumed			-1.345	193.3	.180	-.87	.65

in mathematics achievement of students in three of the four preference scale categories, i.e., Extrovert/Introvert, Thinking/Feeling, and Judging/Intuition (Tables 4, 6, and 7). However, students with Intuition personality type achieved an average of 1.48 points higher on their mathematics scores than those with Sensing preference. This difference was statistically significant at the alpha level of .05 (Table 5).

H_2: No significant differences exist among students' achievement scores in Intermediate Algebra based on their learning style preferences as measured by the LSI.

Table 8 presents the descriptive statistics for each of the twelve learning styles.

Table 8
Descriptive Statistics
Learning Style Preferences and Mathematics Achievement

Descriptive Statistics

Learning Style		N	Minimum	Maximum	Mean	Std. Deviation
VIO	Mathematic Achievement Score	35	11	26	19.03	4.40
VIW	Mathematic Achievement Score	53	8	29	18.94	4.98
VGO	Mathematic Achievement Score	24	12	26	19.00	3.91
VGW	Mathematic Achievement Score	13	10	27	19.77	5.13
AIO	Mathematic Achievement Score	13	11	25	18.15	4.43
AIW	Mathematic Achievement Score	4	15	25	19.25	4.35
AGO	Mathematic Achievement Score	11	11	20	16.00	2.65
AGW	Mathematic Achievement Score	6	9	19	14.50	3.73
TIO	Mathematic Achievement Score	11	17	26	21.36	3.29
TIW	Mathematic Achievement Score	19	10	28	20.42	5.15
TGO	Mathematic Achievement Score	9	12	26	19.11	4.65
TGW	Mathematic Achievement Score	4	13	23	18.00	4.40

From among the twelve learning style categories, students with TIO learning style (n = 11) had the highest mean achievement score (21.36), while students with AGW learning style (n = 6) had the lowest mean achievement score (14.50). As can be seen in Table 8, in the "cognitive style" category (the ones with V, A, and T designations), majority of students surveyed had Visual (V) preference, n = 125, versus n = 34 for Auditory (A), and n = 43 for Tactile (T). In the "social style" category (the ones with G and I designations), students with Individual (I) preference (n = 135) outnumbered those with Group (G) preference (Table 8). Finally, in the "expressive style" category (those with W and O designations), students showed almost equal preference for Written (W) and Oral (O) expression (n=99 and n = 103, respectively).

The parametric one-way analysis of variance was applied to the sample data to determine whether there were significant differences in the mean mathematics achievement scores for the twelve learning style preferences that were identified by the LSI. The mathematics achievement score was the dependent variable and the learning style preference was the independent variable. As can be seen in Table 9, the effect of the

Table 9
ANOVA
Learning Style Preferences and Mathematics Achievement

		Sum of Squares	df	Mean Square	F	Sig.
Mathematic Achievement Score	Between Groups	341.170	11	31.015	1.526	.125
	Within Groups	3862.118	190	20.327		
	Total	4203.287	201			

learning style preferences on students' achievement was not statistically significant at the alpha level of .05 ($F_{11, 190} = 1.526$, $p = .125$).

Although no significant relationship was found between the twelve learning style categories and the students' mathematics achievement, further analysis was performed to determine if there might be differences in the students' achievement within each of the three learning style categories. The analysis of variance was performed to test whether students with three different learning preferences in the "cognitive style" category are different in their mathematics achievement. Table 10 presents the descriptive statistics for these three groups of students. Table 11 presents the results of the ANOVA. As summarized in Table 11, there are significant differences in mean achievement scores of students in the three preference groups of the cognitive style category (F_2, 199= 5.025, p= 0.007). The Tukey HSD test was performed for the pair wise comparison of the means with results as shown in Table 12. As can be seen in Tables 11 and 12, the

Table 10
Descriptive Statistics
Cognitive Style Preferences and Mathematics Achievement

		N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Mathematic Achievement Score	visual	125	19.06	4.60	.41	8	29
	tactile	34	16.94	3.96	.68	9	25
	auditory	43	20.16	4.53	.69	10	28

Table 11
ANOVA
Cognitive Style Preferences and Mathematics Achievement

		Sum of Squares	df	Mean Square	F	Sig.
Mathematic Achievement Score	Between Groups	202.056	2	101.028	5.025	.007
	Within Groups	4001.231	199	20.107		
	Total	4203.287	201			

Table 12
Post Hoc Multiple Comparisons of Means

Dependent Variable: Mathematic Achievement Score

Tukey HSD

(I) Cognitive Style	(J) Cognitive Style	Mean Difference (I-J)	Std. Error	Sig.
visual	tactile	2.12*	.867	.015
	auditory	-1.10	.793	.167
tactile	visual	-2.12*	.867	.015
	auditory	-3.22*	1.029	.002
auditory	visual	1.10	.793	.167
	tactile	3.22*	1.029	.002

* The mean difference is significant at the .05 level.

differences in mathematics achievement are statistically significant for Auditory versus Tactile and Visual versus Tactile students. Students with Tactile preference achieved a lower average mathematics score than both Auditory and Visual students (16.94 versus20.16 and 19.06 respectively). There was no significant difference, however, between the mathematics scores of the students with Auditory and Visual preferences.

The independent t-test was performed to compare students' achievement scores within each category of "social style" and "expressive styles." Tables 13 and 14 present the results of these tests. As can been seen in Table 13, there was no significant difference in mathematics achievements of students with Individual or Group social preferences. In addition, there was no significant difference in the mathematics achievements of students with Written or Oral expressive preferences (Table 14).

Table 13
Social Style Preferences and Mathematics Achievement

Group Statistics

	Social Style	N	Mean	Std. Deviation	Std. Error Mean
Mathematic Achievement Score	individual	135	19.30	4.67	.40
	social	67	18.21	4.32	.53

Independent t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Mathematic Achievement Score	Equal variances assumed	1.172	.280	1.608	200	.109	1.09	.68

Table 14
Expressive Preferences and Mathematics Achievement

Group Statistics

	Expressive Style	N	Mean	Std. Deviation	Std. Error Mean
Mathematic Achievement Score	written	103	18.84	4.16	.41
	oral	99	19.04	4.99	.50

Independent t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Mathematic Achievement Score	Equal variances assumed	2.851	.093	-.303	200	.762	-.20	.65

H_3: No significant difference exists between students' achievement scores in Intermediate Algebra based on their gender.

Table 15 reports the descriptive statistics for males and females in this study. The mean achievement score for male students (n = 87) was 19.28 with a standard deviation of 3.96. The mean achievement score for females (n = 115) was 18.69 with a standard deviation of 4.99

The independent t-test was applied to the sample data to determine whether there was a significant difference in mathematics achievement scores of students surveyed based on their gender. As can be seen in Table 16, the effect of the gender difference on the students' mathematics achievement was not statistically significant at the .05 level ($t = 0.935$ and $p = .351$).

H_4: There is no significant difference between students' achievement scores in Intermediate Algebra based on their race.

Table 17 reports the descriptive statistics for the race differences. One hundred sixty-four students in the sample were white, with a mean mathematics achievement score

Table 15
Descriptive Statistics
Gender and Mathematics Achievement

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Mathematic Achievement Score	male	87	19.28	3.96	.42
	female	115	18.69	4.99	.47

Table 16
Independent t-test
Gender and Mathematics Achievement

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Mathematic Achievement Score	Equal variances assumed	7.695	.006	.906	200	.366	.59	.65
	Equal variances not assumed			.935	199.5	.351	.59	.63

Table 17
Descriptive Statistics
Race and Mathematics Achievement

	Race	N	Mean	Std. Deviation	Std. Error Mean
Mathematic Achievement Score	White	164	19.51	4.55	.36
	Black	35	16.31	3.68	.62

of 19.51 and standard deviation of 4.55. Thirty-five students in this study were black, with a mean mathematics achievement score of 16.31 and standard deviation of 3.68. Only three of the students in the sample fell in the "other" category. Since this number was not large enough for comparisons, the researcher omitted that category for further analysis.

The independent t-test was applied to the sample data to determine whether there were significant differences in mean mathematics achievement scores based on students' race (white and black). Table 18 shows that the effect of race was statistically significant at the α level of 0.05 ($t=4.459$ and $p< .001$). The results of this study showed that the white students had a significantly higher average mathematics achievement test score than the black students did.

H_5: No significant differences exist in students' achievement scores in Intermediate Algebra based on their gender within each category of learning style preferences.

The two-way analysis of variance was applied to the sample data to determine whether there were significant differences in the students' mathematics achievement test scores based on their gender in each category of learning style preferences that were identified by the Learning Style Inventory. The mathematics achievement test score was the dependent variable and the learning style preference and gender were the independent variables. The results of learning style preferences and gender on mathematics achievement is presented in Table 19. As summarized in Table 19, this interaction effect was not statistically significant at the alpha level of .05 ($F_{11, 178} = .259$, $p = .992$).

Table 18
Independent t-test
Race and Mathematics Achievement

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Mathematic Achievement Score	Equal variances assumed	4.401	.037	3.884	197	.000	3.19	.82
	Equal variances not assumed			4.459	58.6	.000	3.19	.72

Table 19
ANOVA- Interaction Effect of Learning Style Preferences and Gender

Dependent Variable: Mathematics Achievement Score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	409.756	23	17.815	.836	.683
Intercept	31280.517	1	31280.517	1467.744	.000
SEX	.445	1	.445	.021	.885
Learning Style	300.740	11	27.340	1.283	.238
SEX * Learning Style	60.608	11	5.510	.259	.992
Error	3793.531	178	21.312		
Total	76670.000	202			
Corrected Total	4203.287	201			

H_6: No significant difference exists in students' achievement scores in Intermediate Algebra based on their gender within each category of personality types.

The two-way analysis of variance was applied to the sample data to determine whether there were significant differences in the students' mathematics achievement scores based on their gender in each category of personality types that were identified by the MBTI. The mathematics achievement score was the dependent variable and the personality type and gender were the independent variables. The interaction of the personality type and gender on mathematics achievement is presented in Table 20. As can be seen from Table 20, this interaction effect is not statistically significant at the alpha level of .05 ($F_{15, 170} = 1.538$, $p = .096$).

Table 20
ANOVA- Interaction Effect of Personality Type and Gender

Dependent Variable: Mathematic Achievement Score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	793.55	31	25.598	1.276	.166
Intercept	42892.272	1	42892.272	2138.491	.000
SEX	3.123	1	3.123	.156	.694
PROFILE	309.521	15	20.635	1.029	.428
SEX * PROFILE	462.866	15	30.858	1.538	.096
Error	3409.734	170	20.057		
Total	76670.000	202			
Corrected Total	4203.287	201			

H_7: No significant differences exist in students' achievement scores in Intermediate Algebra based on their race within each category of learning style preferences.

The two-way analysis of variance was applied to the sample data to determine whether there were significant differences in the students' mathematics achievement scores based on their race in each category of learning style preferences that were identified by the LSI. The mathematics achievement score was the dependent variable and the learning style preferences and race were the independent variables. The interaction of learning style and race on mathematics achievement is presented in Table 21. As can be seen from Table 21, this interaction effect is not statistically significant at the alpha level of .05 ($F_{10, 176} = .548$, $p = .854$).

Table 21
ANOVA- Interaction Effect of Learning Style Preferences and Race

Dependent Variable: Mathematic Achievement Score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	660.703	22	30.032	1.523	.071
Intercept	20319.029	1	20319.029	1030.683	.000
Learning Style	189.348	11	17.213	.873	.568
RACE	124.028	1	124.028	6.291	.013
Learning Style * RACE	108.097	10	10.810	.548	.854
Error	3469.689	176	19.714		
Total	75552.000	199			
Corrected Total	4130.392	198			

H_8: No significant difference exists in students' achievement scores in Intermediate Algebra based on their race within each category of personality type.

The two-way analysis of variance was applied to the sample data to determine whether there were significant differences in the students' mathematics achievement scores based on their race in each category of personality type that were identified by the MBTI. The mathematics achievement score was the dependent variable and the personality type and race were the independent variables. The results of the interaction between personality type and race on mathematics achievement is presented in Table 22. As can be seen from Table 22, this interaction effect is not statistically significant at the alpha level of .05 ($F_{12, 170}$= .388, p = .966).

Table 22
ANOVA- Interaction Effect of Personality Type and Race

Dependent Variable: Mathematic Achievement Score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	682.084	28	24.360	1.201	.237
Intercept	24080.497	1	24080.497	1187.157	.000
RACE	265.179	1	265.179	13.073	.000
PROFILE	150.187	15	10.012	.494	.942
RACE * PROFILE	94.430	12	7.869	.388	.966
Error	3448.308	170	20.284		
Total	75552.000	199			
Corrected Total	4130.392	198			

H_9: No significant relationship exists between students' personality types and their learning style preferences.

The Chi-square test of independence was applied to the sample data for testing this hypothesis. However, since the sample size was not large enough to allow for inclusion of all sixteen personality types and twelve learning style preferences, which would need a minimum sample size of 960 (16 * 12 * 5 = 960), the researcher separately tested this hypothesis on each of the four categories of personality type preferences, i.e., Extrovert vs. Introvert, Sensing vs. Intuition, Feeling vs. Thinking, and Judging vs. Perceiving. The results of these Chi-square tests are presented in Tables 23 through 26. Table 23 shows that the learning styles of the students were dependent on their personality types in the Extrovert/Introvert category. This relationship was significant at the alpha level of 0.05 (χ^2_{11}= 22.08, p= .024). However, as shown in Tables 24 through 26, there were no significant relationships between students' learning styles and their personality types in any of the other three categories. The reader should be cautioned that in all of the four tests, a number of cells contained less than five observations (8, 6, 4, and 8 cells for Tables 23-26, respectively), rendering the results of these tests less robust.

Table 23
Extrovert/Introvert Personality Type Category
and Learning Style Preference

Crosstabulation

		Extrovert/Introvert		
		Extrovert	Introvert	Total
Learning Style	VIO	24	21	45
	VIW	31	39	70
	VGO	25	8	33
	VGW	11	8	19
	AIO	10	5	15
	AIW	2	4	6
	AGO	8	4	12
	AGW	5	2	7
	TIO	9	4	13
	TIW	6	15	21
	TGO	8	2	10
	TGW	3	2	5
Total		142	114	256

Chi Square Test

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.080	11	.024
Likelihood Ratio	22.797	11	.019
Linear-by-Linear Association	.060	1	.807
N of Valid Cases	256		

Table 24
Sensing/Intuition Personality Type Category
and Learning Style Preference

Crosstabulation

		Sensing/Intuition		
		Sensing	Intuition	Total
Learning Style	VIO	38	7	45
	VIW	51	19	70
	VGO	22	11	33
	VGW	8	11	19
	AIO	8	7	15
	AIW	5	1	6
	AGO	8	4	12
	AGW	5	2	7
	TIO	6	7	13
	TIW	15	6	21
	TGO	8	2	10
	TGW	4	1	5
Total		178	78	256

Chi-square Test

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	18.584	11	.069
Likelihood Ratio	18.270	11	.076
Linear-by-Linear Association	.571	1	.450
N of Valid Cases	256		

Table 25
Thinking/Feeling Personality Type Category
and Learning Style Preference

Crosstabulation

		Thinking/Feeling		
		Thinking	Feeling	Total
Learning Style	VIO	23	22	45
	VIW	41	29	70
	VGO	18	15	33
	VGW	6	13	19
	AIO	9	6	15
	AIW	3	3	6
	AGO	7	5	12
	AGW	2	5	7
	TIO	7	6	13
	TIW	12	9	21
	TGO	6	4	10
	TGW		5	5
Total		134	122	256

Chi-square Test

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.521	11	.326
Likelihood Ratio	14.549	11	.204
Linear-by-Linear Association	.085	1	.770
N of Valid Cases	256		

Table 26
Judging/Perceiving Personality Type Category
and Learning Style Preference

Crosstabulation

		Judging/Perceiving		
		Judging	Perceiving	Total
Learning Style	VIO	21	24	45
	VIW	49	21	70
	VGO	12	21	33
	VGW	9	10	19
	AIO	6	9	15
	AIW	3	3	6
	AGO	8	4	12
	AGW	4	3	7
	TIO	7	6	13
	TIW	12	9	21
	TGO	6	4	10
	TGW	2	3	5
Total		139	117	256

Chi-square

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.311	11	.169
Likelihood Ratio	15.583	11	.157
Linear-by-Linear Association	.004	1	.949
N of Valid Cases	256		

H_{10}: No significant relationship exists between students' personality types and their gender.

The Chi-square test of independence was applied to the sample data in order to test this hypothesis. The results, as presented in Table 27, indicated that the students personality types are significantly related to their sex. This relationship is significant at the alpha level of 0.05 ($\chi^2_{15} = 40.703$, $p < 0.001$). However, in this case too, a number of cells contained less than five observations, rendering the results of the tests less robust. Therefore, as in the case of testing hypothesis 9, the researcher performed four separate Chi-square tests, one for each of the four categories of personality type preferences, i.e., Extrovert vs. Introvert, Sensing vs. Intuition, Feeling vs. Thinking, and Judging vs. Perceiving. Tables 28 through 31 present the results of these tests.

Table 27
Chi-square Test of Independence

Personality Type Versus Gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	40.703	15	.000
Likelihood Ratio	44.351	15	.000
Linear-by-Linear Association	4.948	1	.026
N of Valid Cases	252		

Table 28
Extrovert/Introvert Personality Type Preference versus Gender

Crosstabulation

		Extrovert/Introvert		Total
		Extrovert	Introvert	
Gender	male	54	58	112
	female	88	56	144
Total		142	114	256

Chi-Square-Test

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.242	1	.039		
Continuity[a] Correction	3.736	1	.053		
Likelihood Ratio	4.245	1	.039		
Fisher's Exact Test				.043	.027
Linear-by-Linear Association	4.226	1	.040		
N of Valid Cases	256				

a. Computed only for a 2x2 table

Table 29
Sensing/Intuition Personality Type Preference versus Gender

Crosstabulation

		Sensing/Intuition		
		Sensing	Intuition	Total
Gender	male	71	41	112
	female	107	37	144
Total		178	78	256

Chi-square Test

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.541	1	.060		
Continuity Correction[a]	3.045	1	.081		
Likelihood Ratio	3.526	1	.060		
Fisher's Exact Test				.075	.041
Linear-by-Linear Association	3.528	1	.060		
N of Valid Cases	256				

a. Computed only for a 2x2 table

Table 30
Thinking/Feeling Personality Type Preference versus Gender

Crosstabulation

		Thinking/Feeling		
		Thinking	Feeling	Total
Gender	male	76	36	112
	female	58	86	144
Total		134	122	256

Chi-Square-Test

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	19.210	1	.000		
Continuity Correction[a]	18.120	1	.000		
Likelihood Ratio	19.523	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	19.135	1	.000		
N of Valid Cases	256				

a. Computed only for a 2x2 table

Table 31
Judging/Perceiving Personality Type Preference versus Gender

Crosstabulation

		Judging/Perceiving		
		Judging	Perceiving	Total
Gender	male	51	61	112
	female	88	56	144
Total		139	117	256

Chi-square-Test

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6.159	1	.013		
Continuity Correction[a]	5.547	1	.019		
Likelihood Ratio	6.172	1	.013		
Fisher's Exact Test				.016	.009
Linear-by-Linear Association	6.135	1	.013		
N of Valid Cases	256				

a. Computed only for a 2x2 table

As can be seen from Table 28, students' personality type in the Extrovert Introvert category is significantly related to their gender. This relationship is significant at the alpha level of 0.05 ($\chi^2_1 = 4.242$, $p = 0.039$). According to this study, female students are proportionally more Extrovert than Introvert, while the male students seem to be just evenly distributed between the two categories.

Table 29 indicates that the students personality type in the Sensing-Intuition category is not significantly related to their gender at the alpha level of 0.05 ($\chi^2_1 = 3.541$, $p = 0.060$). Table 29 reveals that although not significant at the .05 level, both male and female students are more Sensing than Feeling. However, female students are proportionally more Sensing than their male counterparts.

According to this study, students' personality type in the Thinking-Feeling category is significantly related to their gender. This relationship is significant at the alpha level of 0.05 ($\chi^2_1 = 19.21$, $p < 0.001$). Table 30 summarizes this finding. According to this study, female students are proportionally more Feeling type while the male students are proportionally more Thinking type.

Table 31 indicates that students' personality type in the Judging-Perceiving category is significantly related to their gender. This relationship is significant at the alpha level of 0.05 ($\chi^2_1 = 6.159$, $p = 0.013$). According to this study, female students are proportionally more Judging while the male students are proportionally more Perceiving types.

H_{11}: No significant relationship exists between students' personality types and their race.

The Chi-square test of independence was applied to the sample data in order to test this hypothesis. The results, as presented in Table 32, indicated that the students' personality types are not related to their race at the alpha level of 0.05 ($\chi^2_{15} = 15.491$, $p = 0.417$). However, as in the case of testing hypothesis 10, the researcher performed four separate Chi-square tests, one for each of the four categories of personality type preferences, i.e., Extrovert vs. Introvert, Sensing vs. Intuition, Feeling vs. Thinking, and Judging vs. Perceiving. Tables 33 through 36 present the results of these tests.

Table 32
Chi-square Test of Independence

Personality Type versus Race

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.491	15	.417
Likelihood Ratio	17.369	15	.297
Linear-by-Linear Association	.087	1	.768
N of Valid Cases	252		

Table 33
Extrovert/Introvert Personality Type Preference versus Race

Crosstabulation

		Extrovert/Introvert		Total
		Extrovert	Introvert	
Race	White	114	90	204
	Black	27	21	48
Total		141	111	252

Chi-square-Test

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.002	1	.963		
Continuity Correction[a]	.000	1	1.000		
Likelihood Ratio	.002	1	.963		
Fisher's Exact Test				1.000	.547
Linear-by-Linear Association	.002	1	.963		
N of Valid Cases	252				

a. Computed only for a 2x2 table

Table 34
Sensing/Intuition Personality Type Preference versus Race

Crosstabulation

		Sensing/Intuition		
		Sensing	Intuition	Total
Race	White	135	69	204
	Black	39	9	48
Total		174	78	252

Chi-square-Test

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.131	1	.042		
Continuity[a] Correction	3.456	1	.063		
Likelihood Ratio	4.445	1	.035		
Fisher's Exact Test				.055	.029
Linear-by-Linear Association	4.115	1	.043		
N of Valid Cases	252				

a. Computed only for a 2x2 table

Table 35
Thinking/Feeling Personality Type Preference versus Race

Crosstabulation

		Thinking/Feeling		
		Thinking	Feeling	Total
Race	White	107	97	204
	Black	24	24	48
Total		131	121	252

Chi-square-Test

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.094	1	.760		
Continuity Correction[a]	.021	1	.885		
Likelihood Ratio	.093	1	.760		
Fisher's Exact Test				.873	.442
Linear-by-Linear Association	.093	1	.760		
N of Valid Cases	252				

a. Computed only for a 2x2 table

Table 36
Judging/Perceiving Personality Type Preference versus Race

Crosstabulation

		Judging/Perceiving		
		Judging	Perceiving	Total
Race	White	107	97	204
	Black	28	20	48
Total		135	117	252

Chi-square-Test

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.541	1	.462		
Continuity Correction[a]	.330	1	.566		
Likelihood Ratio	.543	1	.461		
Fisher's Exact Test				.521	.284
Linear-by-Linear Association	.538	1	.463		
N of Valid Cases	252				

a. Computed only for a 2x2 table

As can be seen from Table 33, students' personality type in the Extrovert-Introvert category is not significantly related to their race ($\chi^2_1 = 0.002$, p= 0.963). However, Table 34 indicates that the students personality type in the Sensing-Intuition category is significantly related to their gender at the alpha level of 0.05 ($\chi^2_1 = 4.131$, p= 0.042). As can be seen from Table 34, although both Black and White students are more Sensing than Intuition Type, there is a higher proportion of the Black students who are Sensing than their White counterparts (39/48 = .81 for Blacks versus 135/204 = .66 for Whites).

As can be seen from Tables 35 and 36, students' personality type in the Thinking-Feeling and Judging-Perceiving categories are not significantly related to their race at the alpha level of 0.05 ($\chi^2_1 = 0.094$, p=0.76 and $\chi^2_1 = 0.541$, p=0462, respectively).

H_{12}: No significant relationship exists between students' learning style and their gender.

The Chi-square test of independence was applied to the sample data to test this hypothesis. The results, as presented in Table 37, indicated that students' learning styles are not dependent on their gender at the alpha level of 0.05 ($\chi^2_{11} = 11.163$, p=0.430). In order to examine if students' learning style preferences in any of the three subgroups was dependent on their gender, the researcher performed three separate Chi-square tests on cognitive style (visual--V, auditory--A, and tactile--T), social style (social individual--I, and social group--G), and expressive style (written expressive--W, and oral expressive--O) categories. The results of these tests are presented in Tables 38 through 40. As can be seen from these Tables, in none of the three sub-groups were the students' learning style preferences significantly dependent on their gender.

Table 37
Chi-square Test of Independent

Learning Style versus Gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.163	11	.430
Likelihood Ratio	11.543	11	.399
Linear-by-Linear Association	4.245	1	.039
N of Valid Cases	252		

Table 38
Cognitive Style Preference versus gender

Descriptive Statistics

		Cognative Style			
		visual	tactile	auditory	Total
Gender	male	66	19	27	112
	female	101	21	22	144
Total		167	40	49	256

Chi-square Test

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.008	2	.135
Likelihood Ratio	3.991	2	.136
Linear-by-Linear Association	3.992	1	.046
N of Valid Cases	256		

Table 39
Social Style Preference versus gender

Descriptive Statistics

		Social Style		
		group	individual	Total
Gender	male	38	74	112
	femal	48	96	144
Total		86	170	256

Chi-square Test

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.010	1	.920		
Continuity[a] Correction	.000	1	1.000		
Likelihood Ratio	.010	1	.920		
Fisher's Exact Test				1.000	.513
Linear-by-Linear Association	.010	1	.920		
N of Valid Cases	256				

a. Computed only for a 2x2 table

Table 40
Expressive Style Preference versus gender

Descriptive Statistics

		Expressive Style		
		Written Expressive	Oral Expressive	Total
Gender	male	50	62	112
	female	78	66	144
Total		128	128	256

Chi-square Test

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.286	1	.131		
Continuity[a] Correction	1.921	1	.166		
Likelihood Ratio	2.289	1	.130		
Fisher's Exact Test				.166	.083
Linear-by-Linear Association	2.277	1	.131		
N of Valid Cases	256				

a. Computed only for a 2x2 table

H_{13}: No significant relationship exists between students' learning styles and their race.

The Chi-square test of independence was applied to the sample data to test this hypothesis. The results, as presented in Table 41, indicated that students' learning styles are not dependent on their race at the alpha level of 0.05 ($\chi^2_{11} = 7.24$, p=0.779).

In order to examine if students' learning style preferences in any of the three sub groups was dependent on their race, the researcher performed three separate Chi-square tests on cognitive style (visual--V, auditory--A, and tactile--T), social style (social individual--I, and social group--G), and expressive style (written expressive--W, and oral expressive--O) categories. The results of these tests are presented in Tables 42 through 44. As can be seen from these Tables, in none of the three sub-groups, students' learning style preferences was significantly dependent on their race.

Table 41
Chi-square Test of Independent

Learning Style versus Race

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.240	11	.779
Likelihood Ratio	9.100	11	.613
Linear-by-Linear Association	.320	1	.571
N of Valid Cases	252		

Table 42
Cognitive Style Preference versus Race

Descriptive Statistics

		Cognitive Style			
		visual	tactile	auditory	Total
Race	White	134	28	42	204
	Black	31	11	6	48
Total		165	39	48	252

Chi-square Test

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.463	2	.177
Likelihood Ratio	3.400	2	.183
Linear-by-Linear Association	.300	1	.584
N of Valid Cases	252		

Table 43
Social Style Preference versus Race

Descriptive Statistics

		Social Style		
		group	individual	Total
Race	White	70	134	204
	Black	15	33	48
Total		85	167	252

Chi-square Test

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.163	1	.686		
Continuity Correction[a]	.055	1	.815		
Likelihood Ratio	.165	1	.685		
Fisher's Exact Test				.737	.412
Linear-by-Linear Association	.163	1	.687		
N of Valid Cases	252				

a. Computed only for a 2x2 table

Table 44
Expressive Style Preference versus Race

Descriptive Statistics

		Expressive Style		
		Written Expressive	Oral Expressive	Total
Race	Whit	100	104	204
	Black	26	22	48
Total		126	126	252

Chi-square Test

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.412	1	.521		
Continuity Correction[a]	.232	1	.630		
Likelihood Ratio	.412	1	.521		
Fisher's Exact Test				.631	.315
Linear-by-Linear Association	.410	1	.522		
N of Valid Cases	252				

a. Computed only for a 2x2 table

Summary

The thirteen hypotheses of this study were tested at the 0.05 level of significance. The results are summarized below.

Hypothesis one, "no significant differences exists among students' achievement scores in Intermediate Algebra based on their personality types, as measured by the MBTI," was not rejected. However, when the Independent t-test was performed on each of the four categories of preference scales (Extrovert vs. Introvert, Sensing vs. Intuition, Thinking vs. Feeling, and Judging vs. Perceiving), significant difference was observed in the mathematics performance of the students in the Sensing/Intuition category. That is, students whose learning style preference was Intuition achieved an average of 1.48 points higher on their mathematics scores than those with Sensing preference.

Hypothesis two, "no significant differences exist among students' achievement scores in Intermediate Algebra based on their learning style preferences as measured by the LSI," was not rejected. However, when the analysis of variance was performed to test whether students with three different learning preferences in the "cognitive style" category were different in their mathematics achievement, significant differences were observed. The Tukey HSD test showed significant differences for Auditory versus Tactile and Visual versus Tactile students. Students with Tactile preference achieved a lower average mathematics score than both Auditory and Visual. There was no significant difference, however, between the mathematics scores of the students with Auditory and Visual preferences.

Hypothesis three, "no significant difference exists between students' achievement scores in Intermediate Algebra based on their gender," was not rejected.

Hypothesis four, "no significant difference exists between students' achievement scores in Intermediate Algebra based on their race," was rejected. According to the results, white students had a significantly higher average mathematics achievement test score than their black counterparts.

Hypothesis five, "no significant difference exists in students' achievement scores in Intermediate Algebra based on their gender within each category of learning style preferences," was not rejected.

Hypothesis six, "no significant difference exists in students' achievement scores in Intermediate Algebra based on their gender within each category of personality types," was not rejected.

Hypothesis seven, "no significant difference exists in students' achievement score in intermediate algebra based on their race within each category of learning style preferences," was not rejected.

Hypothesis eight, "no significant difference exists in students' achievement scores in intermediate algebra based on their race within each category of personality type," was not rejected.

Hypothesis nine, "no significant relationship exists between students' personality types and their learning style preferences," was modified to examine, separately, the relationship between learning style preferences and each of the four categories of

personality type preferences. The results indicated that the learning styles of students were dependent on their personality types only in the Extrovert/Introvert category.

Hypothesis ten, "no significant relationship exists between students' personality types and their gender," was rejected. Further analyses revealed the followings. Students' personality type in the Extrovert/Introvert category was related to their gender. Female students were proportionally more Extrovert while male students were proportionally more Introvert types. Also, students' personality types in the Thinking/Feeling category and in the Judging/Perceiving category were related to their gender. Female students were proportionally more Feeling while the male students were proportionally more Thinking types. Moreover, female students are proportionally more Judging while their male counterparts are proportionally more Perceiving types.

Hypothesis eleven, "no significant relationship exists between students' personality types and their race," was not rejected. However, when this relationship was examined separately for each of the four categories of personality type preferences, significant relationships were observed in the Sensing/Intuition category. According to the results, although both black and white students were more Sensing than Intuition type, there was a higher proportion of the black students who were Sensing as compared to their white counterparts.

Hypothesis twelve, no significant relationship exists between students' learning styles and their gender," was not rejected.

Hypothesis thirteen, "no significant relationship exists between students' learning styles and their race," was not rejected.

Chapter V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The primary objective of this research was to investigate the relationship between students' personality types, learning style preferences, and achievement in intermediate algebra. As a secondary purpose, this relationship was investigated based on gender and race comparisons.

To achieve the purposes of this study, three instruments were administered to 202 developmental, Intermediate Algebra students at Chattanooga State Technical Community College (CSTCC) during the Spring semester of 1997. Two of these instruments, the Myers Briggs Type Indicator (MBTI) and the Learning Style Inventory (LSI), were administered to students two months after the beginning of the semester. These two instruments were scored and evaluated by the researcher. The AAPP test was administered and scored at the end of the semester by mathematics faculty of the CSTCC.

Thirteen null hypotheses were formulated and tested in order to accomplish the purposes of this research. Parametric and nonparametric statistics were applied to analyze the collected data. Specific tests that were used included one-way analysis of variance, two-way analysis of variance, Tukey HSD post hoc multiple comparison test, Student-t test, and Chi square test for independence.

Summary of the Results

The majority of developmental algebra students in this research are Extrovert in the Extrovert/Introvert category, Sensing in the Sensing/Intuition category, Thinking in the Thinking/Feeling category, and Judging in the Judging/perceiving category. Although there were no significant differences in mean achievement scores in Intermediate Algebra in the sixteen personality types, students with INFP personality type had the highest mean achievement score and students with ISTJ type had the lowest mean achievement score. Moreover, students with Intuition personality type achieved an average of 1.48 points higher on their mathematics scores than those with Sensing preference. This difference was statistically significant at the .05 level.

The majority of students surveyed had Visual preference for learning in the Cognitive style category and Individual preference for learning in the Social category. In the Expressive style category, students showed almost equal preference for Written and Oral expression.

Most of the developmental algebra students in this study were female and white. Even though there were no significant gender differences in the mathematics achievement mean scores, male students had a higher mathematics achievement mean score than female students. There was a statistically significant racial difference in mathematics achievement mean scores. White students outperformed their black counterparts by 3.2 points.

No statistically significant difference was found across all categories of learning style preferences and personality types. In the Cognitive style category, blacks and whites had almost the same distribution as Visual learners. Blacks were more Tactile than whites,

and whites were more Auditory than blacks. In the personality type categories, the proportion of blacks and whites was the same in the Extrovert/Introvert category and in the Judging/Perceiving category. In the Sensing/Intuition category, however, blacks were more in the Sensing group while whites were more in the Intuition group. In the Thinking/Feeling category, whites were more in the Thinking group and blacks were in more the Feeling category. Students' personality types were significantly related to their gender. Male students were more Introvert and female students were more Extrovert. In the Thinking/Feeling category males were more in the Thinking category and females were more in the Feeling category. In the Judging/Perceiving category, males were more in the Perceiving category while females were more in the Judging category.

In the Cognitive style category, students were more Visual than Tactile or Auditory. Females were more Visual and less Auditory than males. In the Social style category, more students were Individual learners than Group learners and the distribution was the same for male and female students. In the Expressive style category, females were more in the Written category while males were more in the Oral category.

The final finding of this study was that there was a significant relationship between learning style and personality type only in the Extrovert/Introvert category.

Conclusion

As a result of the analysis of data collected for this study, the following conclusions are made.

1. Students' achievement in Intermediate Algebra was not significantly different for sixteen personality types as measured by the MBTI. However, when the Independent t-test was performed on each of the four categories of preference scales (Extrovert vs. Introvert, Sensing vs. Intuition, Thinking vs. Feeling, and Judging vs. Perceiving), a significant difference was observed in the mathematics performance of the students in the Sensing/Intuition category. That is, students whose learning style preference was Intuition achieved an average of 1.48 points higher on their mathematics scores than those with Sensing preference.
2. Students' achievement in Intermediate Algebra was not significantly different for the twelve learning style preferences, as measured by the LSI. However, when the analysis of variance was performed to test whether students with the three different learning preferences in the "cognitive style" category were different in their mathematics achievement, significant differences were observed. The Tukey HSD test showed significant differences for Auditory versus Tactile and Visual versus Tactile students. Students with Tactile preference achieved a lower average mathematics score than both Auditory and Visual. There was no significant difference, however, between the mathematics scores of the students with Auditory and Visual preferences.
3. Students' achievement in Intermediate Algebra was not significantly related to their gender.
4. Students' achievement in Intermediate Algebra was significantly related to their race. According to the results, white students had a significantly higher average mathematics achievement test score than their black counterparts.

5. No significant differences were found in students' achievement scores in Intermediate Algebra based on their gender within each category of learning style preferences.
6. No significant difference was found in students' achievement scores in Intermediate Algebra based on their gender within each category of personality types.
7. No significant difference was found in students' achievement scores in Intermediate Algebra based on their race within each category of learning style preferences.
8. No significant difference was found in students' achievement in Intermediate Algebra based on their race within each category of personality type.
9. Students' personality types was not significantly related to their learning style preferences. However, further analysis revealed that the learning styles of students were significantly dependent on their personality types in the Extrovert/Introvert category.
10. Students' personality types were significantly related to their gender. Further analyses revealed the following. Students' personality type in the Extrovert/Introvert category was related to their gender. Female students were proportionally more Extrovert while male students were proportionally more Introvert types. Also, students' personality types in the Thinking/Feeling category and in the Judging/Perceiving category were related to their gender. Female students were proportionally more Feeling while the male students were proportionally more Thinking types. Moreover, female students were proportionally more Judging while their male counterparts were proportionally more Perceiving types.

11. Students' personality types were not significantly related to their race. However, when this relationship was examined separately for each of the four categories of personality type preferences, significant relationships were observed in the Sensing/Intuition category. According to the results, although both black and white students were more Sensing than Intuition type, there was a higher proportion of the black students who were Sensing as compared to their white counterparts.
12. Students' learning styles were not significantly related to their gender.
13. Students' learning styles were not significantly related to their race.

Discussion

Some of the findings of this research are consistent with the results of previous related studies while some other findings reveal differences between the findings of this study and those reported by other researchers. This section provides a discussion of the findings of this study.

None of the 16 MBTI categories showed significantly higher levels of mathematics achievement than any other type, despite the researcher's conviction that students' personality types would have a significant bearing on their mathematics learning. One possible explanation for this result is that personality type is simply not related to mathematics achievement. This finding is consistent with that of Gillespie (1993), who also reported that there was no significant relationship between the personality types of high school seniors and their mathematics achievement.*

The results of this study indicated that students' achievement in Intermediate Algebra was not significantly different for students with varying learning style preferences.

These results are consistent with findings of Williams (1995), that found that the relationship between students' learning style preferences and achievement gain scores was not significant. It should be noted, however, that this finding of the present study, as well as that of Williams, are based on applying the same teaching method to students with differing learning style preferences.

This study showed no significant difference between male and female students' mathematics achievement. This result is consistent with Ethington's (1990) study that reported no significant gender effect in any of the mathematics content areas in an eight-country international study. The present study also corroborates Jamison's (1994) study that did not find any significant difference in mean SAT mathematics scores for female as compared to male students. This result, however, is different from a number of earlier studies such as those reported by Fennema (1984), Martin and Hoover (1987), and Moore and Smith (1987) in which the authors reported a significant mathematics advantage for male students over their female counterparts. One possible explanation why the findings of the present study is different from those of the earlier research may be attributed to changes in the teachers' and society's beliefs and expectations that mathematics was for male students. Also, referring to the Peterson and Fennema (1985) study in which the authors reported that girls' mathematics achievement was related negatively with a competitive atmosphere and positively with a cooperative classroom climate, another reason for this difference may be attributed to the National Council of Teachers of Mathematics's push for cooperative learning in the recent years, which could have resulted in an atmosphere more conducive to female students' mathematics learning.

This study indicated that there was a significant relationship between mathematics achievement of students and their race. That is, the white students had a significantly higher average mathematics test score than the black students. This result is consistent with the findings of Moore and Smith (1987) and Catsambis (1994). These two studies also reported a significant difference between white and Hispanic students, with the white students achieving higher average mathematics test scores. The present study did not include Hispanics in the comparison due to their extremely low representation in the sample. A number of factors may have contributed to black students' lower level of mathematics achievement. These factors include lower self-confidence due to environmental and economic conditions, absence of family support, lower level of parental education, and lower levels of teachers' expectations (Fennema & Peterson, 1985, Moore & Smith, 1987, Stage & Kloosterman, 1995).

The results of this study indicated that students' learning style preferences were significantly dependent on their personality types only in the Extrovert/Introvert category. The Extrovert students are more Oral Expressive. Students with this learning style tend to talk comfortably and seem to be able to say what they mean. However, organizing and putting their thoughts together in a written format may be a slow and tedious task for these students. After talking to these students about their work, teachers may find that they know more than their tests show. Oral examinations would be the preferred mode of evaluation for this group of students. The Introvert students, on the other hand, are more Written Expressive. Students with this learning style can write fluent essays and good answers on their tests to show what they know. However, they feel less comfortable

when they have to give oral answers. Their thoughts are better organized on paper than when given orally. The traditional written examinations would be the preferred mode of evaluation for this group of students.

This study also showed that students' personality types were significantly related to their gender. These results are in line with those reported by Herbster et al. (1996). In both Herbster and the present study, female students were shown to be more Feeling types while the male students were shown to be more Thinking types. Since the focus of Herbster et al. study was on non-traditional students while the present study dealt with both traditional and non-traditional students, it may be concluded that the personality type differences between male and female students cross the boundaries of traditional and non-traditional students.

Another finding of this study was that there was a significant race difference only in the Sensing/Intuition category of personality type preferences. That is, black students are proportionately more Sensing than their white counterparts. This result is congruent with the Levy, et al. (1972) report. They explained the reason why there were fewer Intuitive types among black students as "it seems likely that the experience of living in a 'majority' dominated world, when attention to immediate and concrete details is necessary for both survival and achievement would impose massive constraints upon the development of 'innate' preferences for intuitive, perceptive mode of experience" (p. 649). However, it should be noted that according to the present study, there are also more Sensing than Intuition type students among the white students (66 vs. 34 percent, respectively). Also, Roberts (1977) in a study of community college students reported

that 73.5 percent of students were Sensing while only 26.5 percent were Intuitive. These findings may be an indication that Sensing and Intuition are more of biological traits than skills that can be acquired.

Recommendations for Practice

Based on the results and experiences of this study the following recommendations are made.

1. Since there are more Sensing than Intuitive students in Intermediate Algebra, and since the Sensing students did not perform as well as their Intuitive counterparts in mathematics achievement, it may be desirable to emphasize learning methods preferred by this type of students. Sensing students learn best when they move from concrete to abstract in a step by step progression. These students benefit from hands-on experience and need to be given clear assignments. Although independent and critical thinking should be encouraged in all mathematics classes, teachers should be aware of the fact that the Sensing students tend not to be independent thinkers.
2. Given the fact that students with Tactile learning style preference achieved significantly lower mathematics scores than their Auditory and Visual counterparts, it is advisable that mathematics teachers pay special attention to this group of students. Students with Tactile learning style also need more hands-on experience and can further be helped through the use of application and daily life oriented problems. These students seek to handle, touch, and work with what they are learning. The manipulation of material, along with sight and sound, will enhance their learning.

3. Since more Visual than Tactile and Auditory students are represented in Intermediate Algebra, instruction methodologies should be developed to particularly accommodate students with this learning style preference. Students with Visual learning style need to see numbers on the board, in a book, or on paper in order to work with them. These students will benefit from worksheets, workbooks, and texts. They also benefit from written instructions.
4. Since students have a variety of different learning style preferences, mathematics educators should provide learning opportunities for students with differing learning modes.
5. Teachers need to pay closer attention to their black students' needs. In a report published in 1995, Melear concluded that "overall, teachers interact less with African American students than with white students" [Melear, in Baker & Scantlebury (editors), 1995, p. 69]. Black students have a greater need than their white counterparts to be recognized and motivated in the classroom (Melear, 1995). Mathematics teachers can also help their black students by using more culturally familiar and daily life examples.
6. Although no significant relationships between students' personality types and their mathematics achievement, or between students' learning style preferences and their mathematics achievement were found, there were significant relationships between students' mathematics achievement and some sub-categories of personality types and learning style preferences. It is the conviction of this researcher that knowing their personality types and learning style preferences would do students no harm rather it

could be a source of help to them. Therefore, it is recommended that community colleges administer learning style and personality type inventories to students in order to help them gain personal insight into their learning preferences and their predominant personality types. This information can be used to help students restructure their learning environments to improve their learning. Furthermore, such information can be used by mathematics teachers to better accommodate students with different personality types and learning style preferences.

Recommendations for Future Research

Based on the results and experiences of this study the following recommendations are made for future research.

1. The present study, as well as previous research (e.g., Gillespie, 1993) showed that Sensing students do not perform as well as Intuitive students in mathematics achievement. A study should be performed to investigate the effects of teachers' personality types in the Sensing/Intuition category on mathematics achievement of students in the same personality type category. This can help examine whether matching or mismatching of students' personality types with those of their teachers could improve students' mathematics achievements of the Sensing/Intuition students.
2. This research study should be replicated with a larger sample size to help make possible some of the chi-square analyses (in relation to hypotheses one and two) that were abandoned in this study due to not having five or more observations in each cell. A larger sample size may also reveal statistical significance for those hypotheses of this study that were not rejected at the α level of .05.

3. This research study should be replicated with a different learning style inventory. The Learning Style Inventory, utilized in this study, may have been too long (forty-five questions) for some students to respond to all questions in an objective manner. That is, due to fatigue or boredom, students may not respond diligently to all questions under time constraint. Kolb's learning style inventory, for example, is a much shorter instrument and may be more suitable for such a study.
4. In the same manner, this research study could also be replicated using a shorter personality type indicator such as Keirsey's instrument, Character and Temperament Type, which is a shorter version of the MBTI.
5. A study should be conducted to determine the effects of matching and mis-matching of students and their teachers learning style preferences on Intermediate Algebra achievement scores. Students would be assigned to an experimental and a control group. In the experimental group, the students' learning style preferences would be identified and appropriate teaching strategies would be applied for each group of students. In the control group, all students would be taught in the same manner, for example, in the traditional teaching method. Mathematics achievement of both experimental and control group students can then be compared and interaction effect of teachers and students' learning style preferences can be evaluated.
6. A study could be conducted to administer a personality type indicator and a learning style inventory to students at the beginning of the semester to see if drop out students have different personality types and/or different learning style preferences as compared to those who do not drop the course. Results of such study could be helpful in

improving the retention rate of students if the study proves that this group of students have certain learning styles or/and personality types which can benefit from school or teachers' intervention.

Concluding Remarks

Most community colleges have open-door policies, thus allowing the enrollment of underprepared students. They provide remedial courses to prepare those students for college level mathematics. The primary goal of the remedial and developmental courses is to prepare students to perform as well in their first college level course as the students who do not need a developmental course. In other words, the developmental courses are designed to provide students with the competencies necessary for college work

The increasing demand for remedial and developmental mathematics courses, however, may not necessarily be indicative of students' inability to learn mathematics. It might be the result of a mismatch between those students learning style preferences and personality types on one hand and course content, learning environment, and instructional methods on the other.

The primary objective of this research was to investigate the relationship between students' personality types, learning style preferences, and achievement in Intermediate Algebra. This study was initiated with the purpose of providing mathematics instructors with such information if those relationships proved significant, who could then modify their pedagogical strategies in order to enhance their students' learning.

Although the study showed no significant relationships between students' learning style preferences and their mathematics achievement, further analysis revealed that

students with Tactile preference achieved lower mathematics scores than their Auditory and Visual counterparts. In the same manner, although the study showed no significant relationships between students' personality types and their mathematics achievements in general, it was found that students with Intuition personality type achieved significantly higher mathematics sores than the students with Sensing personality type. These differences, along with indications from previous research, have led this researcher to believe that learning styles and personality types should be further investigated for their possible impact on students' learning.

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APPENDICES

APPENDIX A

Instruments for Data Collection

CHATTANOOGA STATE TECHNICAL COMMUNITY COLLEGE

Student Informed Consent Form

To: Students enrolled in math 081 in Spring of 1997

From: Azar Raiszadeh, Director of project for determining relationship between students personality, learning style, and their mathematics achievement

The purpose of this letter is to request your participation in a project that will allow me to use some information about you. This project involves collecting the following information about you:

1. Your Chattanooga State Math Placement test score.
2. Your age, gender, and race.
3. Learning Style Inventory (LSI) test, which will be administered today.
4. Myers-Briggs Type Indicator (MBTI) test, which will be administered today.
5. Your score on the post-test, which you will take at the end of the semester.

The portion of above information that is available on you would be taken from records in the Chattanooga State Admissions office. LSI will allow you to learn more about your own learning style. MBTI will allow you to learn more about your personality type. This information may be helpful to you in your studies at chattanooga State Technical Community College and beyond. After these tests have been scored, the researcher will explain how the results affect you personally. Your instructor will inform you of the date when results are ready.

The purpose of this project is to find out whether students' achievement in math 081 is affected by their learning style preferences and or personality types. If this study concludes that such relationship exists, instructors may use this information to develop teaching strategies that will better help students taking this course.

Summary of these data will be used in my Doctoral dissertation. The result of this study will be kept strictly confidential, and only the project director (myself) will have access to the data collected. In fact, after all the data have been collected, the name and social security of each person will be removed and only a subject number will identify you during analyses and any written reports of the research. The student Informed consent forms and all the collected data will be stored in a locked cabinet in my office.

I would appreciate your cooperation in this project. However, you should recognize that your participation in this project is voluntary and you may withdraw from this study at any time without penalty. Your decision whether or not to participate in this study will not affect your grade in this course. If you have any questions regarding this study or your participation in it, now or later, you may contact me at the address and telephone number listed below.

Azar Raiszadeh
Chattanoga State Technical Community College
243 IMC-building
4501 Amnicola HWY.
Chattanooga, TN 37496

Phone 423-697-2520

Your total participation time in this project will be approximately one hour. If you agree to participate in this project as described above, please sign your name below.

Signature_____, Date_____

ID Number_____

LEARNING STYLES INVENTORY

Instructions: Read the statement carefully and circle the number that best agrees with how you feel about the statement.

Sample: I would rather do work in the afternoon than in the morning. (1) (2) (3) (4)

A number "4" response means that you prefer to work in the afternoon. A response of "1" means that you very much prefer to work in the mornings. There is no right or wrong response, only the way you feel about the statement. You may have all the time you need, so please respond to every statement. If there are no questions, you may begin.

	Least Like Me			Most Like Me
1. Making things for my studies helps me to remember what I have learned.	(1)	(2)	(3)	(4)
2. I can write about most of the things I know better than I can tell about them.	(1)	(2)	(3)	(4)
3. When I really want to understand what I have read, I read it softly to myself.	(1)	(2)	(3)	(4)
4. I get more done when I work alone.	(1)	(2)	(3)	(4)
5. I remember what I have read better than what I have heard.	(1)	(2)	(3)	(4)
6. When I answer questions, I can say the answer better than I can write it.	(1)	(2)	(3)	(4)
7. When I do math problems in my head, I say the numbers to myself.	(1)	(2)	(3)	(4)
8. I enjoy joining in on class discussions.	(1)	(2)	(3)	(4)
9. I understand a math problem that is written down better than one that I hear.	(1)	(2)	(3)	(4)
10. I do better when I can write the answer instead of having to say it.	(1)	(2)	(3)	(4)
11. I understand spoken directions better than written ones.	(1)	(2)	(3)	(4)
12. I like to work by myself.	(1)	(2)	(3)	(4)
13. I would rather read a story than listen to it read.	(1)	(2)	(3)	(4)
14. I would rather show and explain how a thing works than write about how it works.	(1)	(2)	(3)	(4)
15. If someone tells me three numbers to add, I can usually get the right answer without writing them down.	(1)	(2)	(3)	(4)
16. I prefer to work with a group when there is work to be done.	(1)	(2)	(3)	(4)
17. A graph or chart of numbers is easier for me to understand than hearing the numbers said.	(1)	(2)	(3)	(4)
18. Writing a spelling word several times helps me remember it better.	(1)	(2)	(3)	(4)
19. I learn better if someone reads a book to me than if I read it silently to myself.	(1)	(2)	(3)	(4)
20. I learn best when I study alone.	(1)	(2)	(3)	(4)

Name _____ Class_____ Date_____

DK-28090 LEARNING STYLES INVENTORY
Educational Activities, Inc., Freeport, NY 11520

LEARNING STYLES INVENTORY

	Least Like Me			Most Like Me
21. When I have a choice between reading and listening, I usually read.	(1)	(2)	(3)	(4)
22. I would rather tell a story than write it.	(1)	(2)	(3)	(4)
23. Saying the multiplication tables over and over helps me remember them better than writing them over and over.	(1)	(2)	(3)	(4)
24. I do my best work in a group.	(1)	(2)	(3)	(4)
25. I understand a math problem that is written down better than one I hear.	(1)	(2)	(3)	(4)
26. In a group project, I would rather make a chart or poster than gather the information to put on it.	(1)	(2)	(3)	(4)
27. Written assignments are easy for me to follow.	(1)	(2)	(3)	(4)
28. I remember more of what I learn if I learn it alone.	(1)	(2)	(3)	(4)
29. I do well in classes where most of the information has to be read.	(1)	(2)	(3)	(4)
30. I would enjoy giving an oral report to the class.	(1)	(2)	(3)	(4)
31. I learn math better from spoken explanations than written ones.	(1)	(2)	(3)	(4)
32. If I have to decide something, I ask other people for their opinions.	(1)	(2)	(3)	(4)
33. Written math problems are easier for me to do than oral ones.	(1)	(2)	(3)	(4)
34. I like to make things with my hands.	(1)	(2)	(3)	(4)
35. I don't mind doing written assignments.	(1)	(2)	(3)	(4)
36. I remember things I hear better than things I read.	(1)	(2)	(3)	(4)
37. I learn better by reading than by listening.	(1)	(2)	(3)	(4)
38. It is easy for me to tell about the things that I know.	(1)	(2)	(3)	(4)
39. It makes it easier when I say the numbers of a problem to myself as I work the problem out.	(1)	(2)	(3)	(4)
40. If I understand a problem, I like to help someone else understand it too.	(1)	(2)	(3)	(4)
41. Seeing a number makes more sense to me than hearing a number.	(1)	(2)	(3)	(4)
42. I understand what I have learned better when I am involved in making something for the subject.	(1)	(2)	(3)	(4)
43. The things I write on paper sound better than when I say them.	(1)	(2)	(3)	(4)
44. I find it easier to remember what I have heard than what I have read.	(1)	(2)	(3)	(4)
45. It is fun to learn with classmates, but it is hard to study with them.	(1)	(2)	(3)	(4)

Name _____ Class_____ Date_____

DK–28090 LEARNING STYLES INVENTORY
Educational Activities, Inc., Freeport, NY 11520

PART I. Which Answer Comes Closer to Telling How You Usually Feel or Act?

1. When you go somewhere for the day, would you rather
   (A) plan what you will do and when, or
   (B) just go?

2. If you were a teacher, would you rather teach
   (A) fact courses, or
   (B) courses involving theory?

3. Are you usually
   (A) a "good mixer," or
   (B) rather quiet and reserved?

4. Do you prefer to
   (A) arrange dates, parties, etc., well in advance, or
   (B) be free to do whatever looks like fun when the time comes?

5. Do you usually get along better with
   (A) imaginative people, or
   (B) realistic people?

6. Do you more often let
   (A) your heart rule your head, or
   (B) your head rule your heart?

7. When you are with a group of people, would you usually rather
   (A) join in the talk of the group, or
   (B) talk with one person at a time?

8. Are you more successful
   (A) at dealing with the unexpected and seeing quickly what should be done, or
   (B) at following a carefully worked out plan?

9. Would you rather be considered
   (A) a practical person, or
   (B) an ingenious person?

10. In a large group, do you more often
    (A) introduce others, or
    (B) get introduced?

11. Do you admire more the people who are
    (A) conventional enough never to make themselves conspicuous, or
    (B) too original and individual to care whether they are conspicuous or not?

12. Does following a schedule
    (A) appeal to you, or
    (B) cramp you?

13. Do you tend to have
    (A) deep friendships with a very few people, or
    (B) broad friendships with many different people?

14. Does the idea of making a list of what you should get done over a weekend
    (A) appeal to you, or
    (B) leave you cold, or
    (C) positively depress you?

15. Is it a higher compliment to be called
    (A) a person of real feeling, or
    (B) a consistently reasonable person?

16. Among your friends, are you
    (A) one of the last to hear what is going on, or
    (B) full of news about everybody?

[On this next question *only*, if two answers are true, mark both.]

17. In your daily work, do you
    (A) rather enjoy an emergency that makes you work against time, or
    (B) hate to work under pressure, or
    (C) usually plan your work so you won't *need* to work under pressure?

18. Would you rather have as a friend
    (A) someone who is always coming up with new ideas, or
    (B) someone who has both feet on the ground?

19. Do you
    (A) talk easily to almost anyone for as long as you have to, or
    (B) find a lot to say only to certain people or under certain conditions?

20. When you have a special job to do, do you like to
    (A) organize it carefully before you start, or
    (B) find out what is necessary as you go along?

21. Do you usually
    (A) value sentiment more than logic, or
    (B) value logic more than sentiment?

22. In reading for pleasure, do you
    (A) enjoy odd or original ways of saying things, or
    (B) like writers to say exactly what they mean?

23. Can the new people you meet tell what you are interested in
    (A) right away, or
    (B) only after they really get to know you?

24. When it is settled well in advance that you will do a certain thing at a certain time, do you find it
    (A) nice to be able to plan accordingly, or
    (B) a little unpleasant to be tied down?

25. In doing something that many other people do, does it appeal to you more to
    (A) do it in the accepted way, or
    (B) invent a way of your own?

26. Do you usually
    (A) show your feelings freely, or
    (B) keep your feelings to yourself?

Go on to Part II.

PART II. Which Word in Each Pair Appeals to You More?

Think what the words mean, not how they look or how they sound.

27.	(A)	scheduled	unplanned	(B)	50.	(A)	sensible	fascinating	(B)
28.	(A)	gentle	firm	(B)	51.	(A)	forgive	tolerate	(B)
29.	(A)	facts	ideas	(B)	52.	(A)	production	design	(B)
30.	(A)	thinking	feeling	(B)	53.	(A)	impulse	decision	(B)
31.	(A)	hearty	quiet	(B)	54.	(A)	who	what	(B)
32.	(A)	convincing	touching	(B)	55.	(A)	speak	write	(B)
33.	(A)	statement	concept	(B)	56.	(A)	uncritical	critical	(B)
34.	(A)	analyze	sympathize	(B)	57.	(A)	punctual	leisurely	(B)
35.	(A)	systematic	spontaneous	(B)	58.	(A)	concrete	abstract	(B)
36.	(A)	justice	mercy	(B)	59.	(A)	changing	permanent	(B)
37.	(A)	reserved	talkative	(B)	60.	(A)	wary	trustful	(B)
38.	(A)	compassion	foresight	(B)	61.	(A)	build	invent	(B)
39.	(A)	systematic	casual	(B)	62.	(A)	orderly	easygoing	(B)
40.	(A)	calm	lively	(B)	63.	(A)	foundation	spire	(B)
41.	(A)	benefits	blessings	(B)	64.	(A)	quick	careful	(B)
42.	(A)	theory	certainty	(B)	65.	(A)	theory	experience	(B)
43.	(A)	determined	devoted	(B)	66.	(A)	sociable	detached	(B)
44.	(A)	literal	figurative	(B)	67.	(A)	sign	symbol	(B)
45.	(A)	firm-minded	warm-hearted	(B)	68.	(A)	party	theater	(B)
46.	(A)	imaginative	matter-of-fact	(B)	69.	(A)	accept	change	(B)
47.	(A)	peacemaker	judge	(B)	70	(A)	agree	discuss	(B)
48.	(A)	make	create	(B)	71.	(A)	known	unknown	(B)
49.	(A)	soft	hard	(B)					

Go on to Part III.

PART III. Which Answer Comes Closer to Telling How You Usually Feel or Act?

72. Would you say you
    (A) get more enthusiastic about things than the average person, or
    (B) get less excited about things than the average person?

73. Do you feel it is a worse fault to be
    (A) unsympathetic, or
    (B) unreasonable?

74. Do you
    (A) rather prefer to do things at the last minute, or
    (B) find doing things at the last minute hard on the nerves?

75. At parties, do you
    (A) sometimes get bored, or
    (B) always have fun?

76. Do you think that having a daily routine is
    (A) a comfortable way to get things done, or
    (B) painful even when necessary?

77. When something new starts to be the fashion, are you usually
    (A) one of the first to try it, or
    (B) not much interested?

78. When you think of some little thing you should do or buy, do you
    (A) often forget it till much later, or
    (B) usually get it down on paper to remind yourself, or
    (C) always carry through on it without reminders?

79. Are you
    (A) easy to get to know, or
    (B) hard to get to know?

80. In your way of living, do you prefer to be
    (A) original, or
    (B) conventional?

81. When you are in an embarrassing spot, do you usually
    (A) change the subject, or
    (B) turn it into a joke, or
    (C) days later, think of what you should have said?

82. Is it harder for you to adapt to
    (A) routine, or
    (B) constant change?

83. Is it higher praise to say someone has
    (A) vision, or
    (B) common sense?

84. When you start a big project that is due in a week, do you
    (A) take time to list the separate things to be done and the order of doing them, or
    (B) plunge in?

85. Do you think it more important to be able
    (A) to see the possibilities in a situation, or
    (B) to adjust to the facts as they are?

86. Do you think the people close to you know how you feel
    (A) about most things, or
    (B) only when you have had some special reason to tell them?

87. Would you rather work under someone who is
    (A) always kind, or
    (B) always fair?

88. In getting a job done, do you depend on
    (A) starting early, so as to finish with time to spare, or
    (B) the extra speed you develop at the last minute?

89. Do you feel it is a worse fault
    (A) to show too much warmth, or
    (B) not to have warmth enough?

90. When you are at a party, do you like to
    (A) help get things going, or
    (B) let the others have fun in their own way?

91. Would you rather
    (A) support the established methods of doing good, or
    (B) analyze what is still wrong and attack unsolved problems?

92. Are you more careful about
(A) people's feelings, or
(B) their rights?

93. If you were asked on a Saturday morning what you were going to do that day, would you
(A) be able to tell pretty well, or
(B) list twice too many things, or
(C) have to wait and see?

94. In deciding something important, do you
(A) find you can trust your feeling about what is best to do, or
(B) think you should do the *logical* thing, no matter how you feel about it?

95. Do you find the more routine parts of your day
(A) restful, or
(B) boring?

96. Does the importance of doing well on a test make it generally
(A) easier for you to concentrate and do your best, or
(B) harder for you to concentrate and do yourself justice?

97. Are you
(A) inclined to enjoy deciding things, or
(B) just as glad to have circumstances decide a matter for you?

98. In listening to a new idea, are you more anxious to
(A) find out all about it, or
(B) judge whether it is right or wrong?

99. In any of the ordinary emergencies of everyday life, would you rather
(A) take orders and be helpful, or
(B) give orders and be responsible?

100. After being with superstitious people, have you
(A) found yourself slightly affected by their superstitions, or
(B) remained entirely unaffected?

101. Are you more likely to speak up in
(A) praise, or
(B) blame?

102. When you have a decision to make, do you usually
(A) make it right away, or
(B) wait as long as you reasonably can before deciding?

103. At the time in your life when things piled up on you the worst, did you find
(A) that you had gotten into an impossible situation, or
(B) that by doing only the necessary things you could work your way out?

104. Out of all the good resolutions you may have made, are there
(A) some you have kept to this day, or
(B) none that have really lasted?

105. In solving a personal problem, do you
(A) feel more confident about it if you have asked other people's advice, or
(B) feel that nobody else is in as good a position to judge as you are?

106. When a new situation comes up which conflicts with your plans, do you try first to
(A) change your plans to fit the situation, or
(B) change the situation to fit your plans?

107. Are such emotional "ups and downs" as you may feel
(A) very marked, or
(B) rather moderate?

108. In your personal beliefs, do you
(A) cherish faith in things that cannot be proved, or
(B) believe only those things that can be proved?

109. In your home life, when you come to the end of some undertaking, are you
(A) clear as to what comes next and ready to tackle it, or
(B) glad to relax until the next inspiration hits you?

110. When you have a chance to do something interesting, do you
(A) decide about it fairly quickly, or
(B) sometimes miss out through taking too long to make up your mind?

111. If a breakdown or mix-up halted a job on which you and a lot of others were working, would your impulse be to
(A) enjoy the breathing spell, or
(B) look for some part of the work where you could still make progress, or
(C) join the "trouble-shooters" in wrestling with the difficulty?

112. When you don't agree with what has just been said, do you usually
(A) let it go, or
(B) put up an argument?

113. On most matters, do you
(A) have a pretty definite opinion, or
(B) like to keep an open mind?

114. Would you rather have
(A) an opportunity that may lead to bigger things, or
(B) an experience that you are sure to enjoy?

115. In managing your life, do you tend to
(A) undertake too much and get into a tight spot, or
(B) hold yourself down to what you can comfortably handle?

116. When playing cards, do you enjoy most
(A) the sociability, or
(B) the excitement of winning, or
(C) the problem of getting the most out of each hand,
(D) or don't you enjoy playing cards?

117. When the truth would not be polite, are you more likely to tell
(A) a polite lie, or
(B) the impolite truth?

118. Would you be more willing to take on a heavy load of extra work for the sake of
(A) extra comforts and luxuries, or
(B) a chance to achieve something important?

119. When you don't approve of the way a friend is acting, do you
(A) wait and see what happens, or
(B) do or say something about it?

120. Has it been your experience that you
(A) often fall in love with a notion or project that turns out to be a disappointment—so that you "go up like a rocket and come down like the stick", or do you
(B) use enough judgment on your enthusiasms so that they do not let you down?

121. When you have a serious choice to make, do you
(A) almost always come to a clear-cut decision, or
(B) sometimes find it so hard to decide that you do not wholeheartedly follow up either choice?

122. Do you usually
(A) enjoy the present moment and make the most of it, or
(B) feel that something just ahead is more important?

123. When you are helping in a group undertaking, are you more often struck by
(A) the cooperation, or
(B) the inefficiency,
(C) or don't you get involved in group undertakings?

124. When you run into an unexpected difficulty in something you are doing, do you feel it to be
(A) a piece of bad luck, or
(B) a nuisance, or
(C) all in the day's work?

125. Which mistake would be more natural for you:
(A) to drift from one thing to another all your life, or
(B) to stay in a rut that didn't suit you?

126. Would you have liked to argue the meaning of
(A) a lot of these questions, or
(B) only a few?

III. INTERMEDIATE ALGEBRA SKILLS TEST

Cluster A: Algebraic Operations (Tested at a higher level than in the Elementary Algebra Skills Test)

1. Squaring a binomial
2. Factoring difference of squares
3. Factoring $ax^2 + bx + c$ over the rationals
4. Factoring polynomials of degree greater than two
5. Simplification of rational algebraic expressions involving addition, subtraction, multiplication, and division
6. Positive rational exponents and roots

Cluster B: Solution of Equations and Inequalities

7. Solving linear equations
8. Solving fractional equations (e.g., $\frac{2}{x} - 1 = 3$)
9. Solving an equation involving absolute value (e.g., $|x + 1| = 5$)
10. Solving a linear inequality
11. Solving a system of 2 linear equations
12. Solution of a polynomial equation in factored form (degree ≥ 2)
13. Solution of a quadratic equation in form $ax^2 + bx + c = 0$ (factorable)
14. Solution of a quadratic equation having irrational roots (quadratic formula)
15. Solving quadratic inequalities (e.g., $ax^2 + bx + c > 0$)

Cluster C: Coordinate Plane and Graphs

16. Locating points in rectangular coordinates
17. Determining the distance between two points
18. Slope of a line through two given points
19. Finding an equation of a line, given a point and the slope
20. Given a linear equation, finding its slope and y-intercept
21. Finding an equation of a line parallel to a given line
22. Finding an equation of a line perpendicular to a given line
23. Identifying graphs of linear equations and inequalities
24. Identifying graphs of quadratic equations and inequalities

APPENDIX B

Course Contents and Class Schedule

Spring 1997
Schedule of Classes
Mathematics 081

MA 081	01	INTERMED ALGEBRA	5	IMC	250	MTWRF	0700AM	0750AM	STAFF
MA 081	02	INTERMED ALGEBRA/ INTERACTIVE	5	H	109	MTWRF	0800AM	0850AM	BARTLEY S
MA 081	03	INTERMED ALGEBRA	5	IMC	250	MTWRF	0800AM	0850AM	HARLEY G
MA 081	04	INTERMED ALGEBRA	5	IMC	251	MTWRF	0900AM	0950AM	BARTLEY S
MA 081	05	INTERMED ALGEBRA	5	S	213	MTWRF	0900AM	0950AM	MCDONALD W
MA 081	06	INTERMED ALGEBRA	5	H	108	MTWRF	0900AM	0950AM	CANNON T
MA 081	07	INTERMED ALGEBRA/ INTERACTIVE	5	IMC	250	MTWRF	0900AM	0950AM	MURDOCK L
MA 081	08	INTERMED ALGEBRA	5	S	213	MTWRF	1000AM	1050AM	MURDOCK L
MA 081	09	INTERMED ALGEBRA/ INTERACTIVE	5	OMN	176	MWF	0900AM	1030AM	LANCE G
MA 081	10	INTERMED ALGEBRA/ INTERACTIVE	5	H	109	MTWRF	1000AM	1050AM	PEACOCK C
MA 081	11	INTERMED ALGEBRA	5	IMC	250	MTWRF	1055AM	1155AM	KABIRI Z
MA 081	12	INTERMED ALGEBRA	5	IMC	250	MTWRF	1200PM	1250PM	PEACOCK C
MA 081	13	INTERMED ALGEBRA	5	OMN	132	MWF	1100AM	1230PM	POLK-CONLEY
MA 081	14	INTERMED ALGEBRA	5	IMC	251	MTWRF	0100PM	0150PM	STANISLAWSKI
MA 081	15	INTERMED ALGEBRA	5	OMN	176	MWF	1100AM	1230PM	BARNES S
MA 081	16	INTERMED ALGEBRA	5	C	77	MWF	1100AM	1230PM	LEWIS D
MA 081	17	INTERMED ALGEBRA	5	IMC	250	MWF	0330PM	0515PM	JENSEN D
MA 081	18	INTERMED ALGEBRA	5	OMN	176	TR	1230PM	0245PM	POLK-CONLEY
MA 081	19	INTERMED ALGEBRA/ INTERACTIVE	5	OMN	130	MWF	1130AM	0100PM	ROBERTSON P
MA 081	20	INTERMED ALGEBRA	5	OMN	132	MW	0530PM	0745PM	TAYLOR J
MA 081	21	INTERMED ALGEBRA	5	IMC	125	TR	0530PM	0745PM	CONNELLY R
MA 081	22	INTERMED ALGEBRA	5	IMC	250	TR	0530PM	0810PM	BLANCHARD G
MA 081	24	INTERMED ALGEBRA	5	IMC	250	F	0530PM	0810PM	RADDEN D
				IMC	250	S	1230PM	0230PM	
MA 081	25	INTERMED ALGEBRA	5	H	227	MW	0530PM	0745PM	SADRE-ORAFAI
MA 081	33	INTERMED ALGEBRA	5	S	214	MTW	0100PM	0150PM	ELLINGER R
				S	214	R	0200PM	0330PM	
MA 081	56	INTERMED ALGEBRA	5	IMC	250	MTWRF	0955AM	1055AM	LAYMON B
MA 081	56	INTERMED ALGEBRA	5	S	214	TR	0530PM	0810PM	STEVENS T
MA 081	57	INTERMED ALGEBRA	5	H	109	MTWRF	0855AM	0955AM	WHITE M
MA 081	66	INTERMED ALGEBRA	5	C	77	MTWRF	1000AM	1050AM	STAFF
MA 081	66	INTERMED ALGEBRA	5	IMC	125	MW	0530PM	0745PM	DARK J
MA 081	67	INTERMED ALGEBRA	5	H	109	MTWRF	1100AM	1150AM	CANNON T
MA 081	PR	INTERMED ALGEBRA	5	EAST	101	MTWRF	0900AM	0950AM	ZUCKERMAN S
MA 081	PS	INTERMED ALGEBRA	5	WEST	0	MTWRF	1100AM	1150AM	STUBSTEN ERI
MA 081	PS	INTERMED ALGEBRA	5	WEST	0	TR	0530PM	0745PM	RUSSELL R
MA 081	PT	INTERMED ALGEBRA	5	NRTH	0	MTWRF	0900AM	0950AM	RYAN G
MA 081	PT	INTERMED ALGEBRA	5	NRTH	0	TR	0530PM	0745PM	STAFF

SPRING 1997				
MA 081-56&57 M-F	MA 081-56N T R		MA 081-66&67 M-F	MA 081- 66N MW
		Jan-09	Orient, Rev. Linear Graphing	
		10	Review Linear Graphing	
		Jan-13	13.1*	Orient, Rev. Linear Graphing
		14	13.1*	
		15	12.7*	13.1*, Review 12.7*
		16	Review 12.7*	
		17	Appendix K*	
HOLIDAY	HOLIDAY	Jan-20	HOLIDAY	HOLIDAY
Orientation, AT	Orient., AT, 10.1*, 10.2*	21	Appendix K*	
10.1*		22	13.2*	Appendix K*
10.1*	10.2*, 10.3*	23	13.3*	
10.2*		24	13.3*	
10.2*		Jan-27	13.4*	13.2*, 13.3*
10.3*	10.4*, 10.5*	28	13.4*	
10.3*		29	13.4*	13.3*, 13.4*
10.4*	10.5*, 10.6*	30	13.5	
10.4*		31	13.5	
10.5*		Feb-03	Review	13.5
10.5*	10.6*, 10.7*	4	Review	
10.6*		5	Chapter 13 Test	Review
10.6*	10.7*, 10.8*	6	Review	
10.7*		7	14.1*	
10.7*		Feb-10	14.1*	Chapter 13 Test, 14.1*
10.8*	10.8*, Review	11	14.2*	
10.8*		12	14.2*	Review, 14.2*
Review	Chapter 10 Test, 11.1*	13	14.3*	
Review		14	14.3*	
Chapter 10 Test		Feb-17	14.4*	14.3*
Review	Review, 11.2*	18	14.4*	
11.1*		19	14.5*	14.4*
11.1*	Review 1.7d, 11.3*	20	14.5*	
11.2*		21	14.6*	
11.2*		Feb-24	14.6*	14.5*
Review 1.7d	11.3*, 11.4*	25	14.6*	
11.3*		26	Appendix I*	14.6*
11.3*	11.5*	27	Appendix I*	
11.4*		28	Appendix I*	
11.4*		Mar-03	Review	Appendix I*
11.5*	11.6*	4	Review	
11.5*		5	Chapter 14 Test	Review
11.6*	11.7*	6	Review	
11.6*		7	15.1*	
11.6*		Mar-10	15.1*	Chapter 14 Test, 15.1*
11.7*	11.8	11	15.2*	
11.7*		12	15.2*	Review, 15.2*
11.8	11.9*	13	15.2*	
11.8		14	15.2*	

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SPRING 1997				
MA 081-56&57 M-F	MA 081-56N T R		MA 081-66&67 M-F	MA 081- 66N MW
SPRING	BREAK	Mar-17	SPRING	BREAK
SPRING	BREAK	18	SPRING	BREAK
SPRING	BREAK	19	SPRING	BREAK
SPRING	BREAK	20	SPRING	BREAK
SPRING	BREAK	21	SPRING	BREAK
11.8		Mar-24	15.3*	15.3*, 15.4
11.9*	Review	25	15.3*	
11.9*		26	15.4	15.4, 15.5
Review	Chapter 11 Test, 13.1*	27	15.4	
HOLIDAY	HOLIDAY	28	HOLIDAY	HOLIDAY
Review		Mar-31	15.5	15.6*
Chapter 11 Test	Rev., Rev. 12.6*, App. K*	Apr-01	15.5	
Review		2	15.6*	Appendix J*
Review 12.2* and 12.3*	13.2*	3	15.6*	
13.1*		4	15.6*	
13.1*		Apr-07	Appendix J*	Appendix G*
Review 12.6*, Appendix K*	13.3*	8	Appendix J*	
Appendix K*		9	Appendix G*	Appendix E
13.2*	13.4*	10	Appendix G*	
13.2*		11	Appendix E	
13.3*		Apr-14	Appendix E	Review
13.4*	13.5	15	Appendix E	
13.4*		16	Review	Chapter 15 Test
13.4*	Review	17	Review	
13.5		18	Chapter 15 Test	
13.5		Apr-21	Review	Review Chapter 10
13.5	Chapter 13 Test, Review	22	Review Chapter 10	
Review		23	Review Chapter 10	Review Chapter 11
Review	Exit Exam Review	24	Review Chapter 11	
Chapter 13 Test		25	Review Chapter 11	
Review		Apr-28	Final/Post Review	Review Chapter 11
Exit Exam Review	Exit Exam Review	29	Final/Post Review	
Exit Exam Review		30	Final/Post Review	Final/Post Review
Exit Exam Review	Exit Exam Review	May-01	Final/Post Review	
Exit Exam Review		2	Final/Post Review	
Exit Exam Review		May-05	Final/Post Review	Final/Post Review
FINAL EXAMS	FINAL EXAMS	6	FINAL EXAMS	FINAL EXAMS
FINAL EXAMS	FINAL EXAMS	7	FINAL EXAMS	FINAL EXAMS
FINAL EXAMS	FINAL EXAMS	8	FINAL EXAMS	FINAL EXAMS
FINAL EXAMS	FINAL EXAMS	9	FINAL EXAMS	FINAL EXAMS
LEGEND:				
ORIENT - ORIENTATION		REV - REVIEW		CH - CHAPTER
AT - ASSESSMENT TEST		APP - APPENDICES or APPENDIX		
* - There is a calculator accompaniment.				

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SPRING 1997				
MA 081 M - F	MA 081 M W F		MA 081 M W	MA 081 T R
Orientation, AT		Jan-09		Orientation, AT, 10.1*.10.2*
10.1*	Orientation, AT, 10.1*	10		
10.2*	10.2*, 10.3*	Jan-13	Orientation, AT, 10.1*.10.2*	
10.3*		14		10.3*, 10.4*, 10.5*
10.4*	10.4*, 10.5*	15	10.3*, 10.4*, 10.5*	
10.5*		16		10.6*, 10.7*, 10.8*
10.6*	10.6*, 10.7*	17		
HOLIDAY	HOLIDAY	Jan-20	HOLIDAY	HOLIDAY
10.7*		21		10.8*, Review
10.8*	10.8*, Review	22	10.6*, 10.7*, 10.8*	
10.8*		23		Ch 10 Test, 11.1*, 11.2*
Review	Chapter 10 Test	24		
Chapter 10 Test	Review, 11.1*	Jan-27	10.8*, Review	
Review		28		Review, Rev 1.7d, 11.3*
11.1*	11.2*, Rev 1.7d, 11.3*	29	Ch 10 Test, 11.1*, 11.2*	
11.2*, Rev. 1.7d		30		11.4*, 11.5*
11.3*	11.3*, 11.4*	31		
11.3*	11.4*, 11.5*	Feb-03	Review, Rev 1.7d, 11.3*	
11.4*		4		11.5*, 11.6*
11.4*	11.5*	5	11.4*, 11.5*	
11.5*		6		11.7*, 11.8
11.5*	11.6*	7		
11.6*	11.7*	Feb-10	11.5*, 11.6*	
11.6*		11		11.8, 11.9*
11.7*	11.8	12	11.7*, 11.8	
11.7*		13		11.9*, Review
11.8	11.9*	14		
11.8	Review	Feb-17	11.8, 11.9*	
11.9*		18		Chapter 11 Test, 13.1*
11.9*	Chapter 11 Test	19	11.9*, Review	
Review		20		REV, Rev 12.6*, App. K*, 13.2*
Chapter 11 Test	Review, 13.1*, Rev.12.6*	21		
Review, 13.1*	App. K*, 13.2*	Feb-24	Chapter 11 Test, 13.1*	
Rev. 12.6*, App. K*		25		13.3*, 13.4*, 13.5
13.2*	13.2*, 13.3*	26	REV, Rev 12.6*, App. K*, 13.2*	
13.3*		27		13.5, Review
13.4*	13.4*	28		
13.4*	13.5	Mar-03	13.3*, 13.4*, 13.5*	
13.5		4		Chapter 13 Test, 14.1*
13.5	Review	5	13.5*, Review	
Review		6		Review, 14.2*, 14.3*
Chapter 13 Test	Chapter 13 Test	7		

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SPRING 1997				
MA 081 M - F	MA 081 M W F		MA 081 M W	MA 081 T R
Rev., 14.1*	Review, 14.1*	Mar-10	Chapter 13 Test, 14.1*	
14.2*		11		14.4*, 14.5*
14.3*	14.2*, 14.3*	12	Review, 14.2*, 14.3*	
14.4*		13		14.6*, App. I*
14.4*	14.4*	14		
SPRING	BREAK	Mar-17	SPRING	BREAK
SPRING	BREAK	18	SPRING	BREAK
SPRING	BREAK	19	SPRING	BREAK
SPRING	BREAK	20	SPRING	BREAK
SPRING	BREAK	21	SPRING	BREAK
14.5*	14.5*	Mar-24	14.4*, 14.5*	
14.5*		25		App. I*, Review
14.6*	14.6*	26	14.6*, App. I*	
App. I*		27		Chapter 14 Test, 15.1*
HOLIDAY	HOLIDAY	28	HOLIDAY	HOLIDAY
App. I*	App. I*	Mar-31	App. I*, Review	
Review		1		Review, 15.2*, 15.3*
Chapter 14 Test	Review	2	Chapter 14 Test, 15.1*	
Review		3		15.4*, 15.5
15.1*	Chapter 14 Test	4		
15.2*	Review, 15.1*	Apr-07	Review, 15.2*, 15.3*	
15.2*		8		15.6*
15.3*	15.2*, 15.3*	9	15.4*, 15.5	
15.3*		10		App. J*, App. G*
15.4	15.4, 15.5	11		
15.5	15.5	Apr-14	15.6*, App. J*	
15.5		15		App. G*, App. E
15.5	15.6*, App. J*	16	App. G*, App. E	
15.6*		17		Review
15.6*	App. J*, App. G*	18		
App. J*	App. E	Apr-21	Review	
App. G*		22		Chapter 15 Test, Final Review
App. E	Review	23	Chapter 15 Test, Final Review	
Review		24		Final/Post Review
Chapter 15 Test	Chapter 15 Test	25		
Review	Review	Apr-28	Final/Post Review	
Final/Post Review		29		Final/Post Review
Final/Post Review	Final/Post Review	30	Final/Post Review	
Final/Post Review		May-01		Final/Post Review
Final/Post Review	Final/Post Review	2		
Final/Post Review	Final/Post Review	May-05	Final/Post Review	
FINAL EXAMS	FINAL EXAMS	6	FINAL EXAMS	FINAL EXAMS
FINAL EXAMS	FINAL EXAMS	7	FINAL EXAMS	FINAL EXAMS
FINAL EXAMS	FINAL EXAMS	8	FINAL EXAMS	FINAL EXAMS
FINAL EXAMS	FINAL EXAMS	9	FINAL EXAMS	FINAL EXAMS
LEGEND:	*There is a calculator accompaniment.			
AT - ASSESSMENT TEST		REV - REVIEW		
CH - CHAPTER		APP - APPENDICES or APPENDIX		

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LATE START SPRING 1997				
MA 081 M - F		MA 081 M W F		MA 081 T R
	Jan-09		Jan-09	
	10		10	
	Jan-13		Jan-13	
	14		14	
	15		15	
	16		16	
	17		17	
HOLIDAY	Jan-20	HOLIDAY	Jan-20	HOLIDAY
Orientation, AT	21		21	Orientation, AT, 10.1*
10.1*	22	Orientation, AT, 10.1*	22	
10.2*	23		23	10.2*, 10.3*
10.3*	24	10.2*, 10.3*	24	
10.4*	Jan-27	10.4*, 10.5*	Jan-27	
10.5*	28		28	10.4*, 10.5*
10.6*	29	10.6*	29	
10.7*	30		30	10.6*, 10.7*
10.8*	31	10.7*	31	
Review	Feb-03	10.8*	Feb-03	
Chapter 10 Test	4		4	10.8*, Review
Review, 11.1*	5	Review	5	
11.2*	6		6	Chapter 10 Test
Review 1.7d,11.3*	7	Chapter 10 Test	7	
11.4*	Feb-10	Rev., 11.1*, 11.2*	Feb-10	
11.4*	11		11	Rev., 11.1*, 11.2*
11.5*	12	Review 1.7d, 11.3*	12	
11.5*	13		13	Review 1.7d, 11.3*, 11.4*
11.6*	14	11.4*, 11.5*	14	
11.7*	Feb-17	11.6*	Feb-17	
11.8	18		18	11.5*, 11.6*
11.8, 11.9*	19	11.7*	19	
11.9*	20		20	11.7*, 11.8*
Review	21	11.8	21	
Chapter 11 Test	Feb-24	11.9*	Feb-24	
Review, 13.1*	25		25	11.9*, Review
Rev. 12.6*, App. K*	26	Review	26	
13.2*	27		27	Ch. 11 Test, Rev. 12.6*, 13.1*
13.3*	28	Chapter 11 Test	28	
13.4*	Mar-03	Review, 13.1*, Rev. 12.6*	Mar-03	
13.4*, 13.5	4		4	Rev., Appendix K*, 13.2*
13.5	5	Appendix K*, 13.2*	5	
Review	6		6	13.3*, 13.4*
Chapter 13 Test	7	13.3*, 13.4*	7	

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LATE START SPRING 1997				
MA 081 M - F		MA 081 M W F		MA 081 T R
Rev., 14.1*	Mar-10	13.5, Review	Mar-10	
14.2*	11		11	13.5, Review
14.3*	12	Chapter 13 Test	12	
14.4*	13		13	Chapter 13 Test, 14.1*
14.4*	14	Review, 14.1*	14	
SPRING	Mar-17	BREAK	Mar-17	HOLIDAY
SPRING	18	BREAK	18	HOLIDAY
SPRING	19	BREAK	19	HOLIDAY
SPRING	20	BREAK	20	HOLIDAY
SPRING	21	BREAK	21	HOLIDAY
14.5*	Mar-24	14.2*, 14.3*	Mar-24	
14.5*	25		25	Review, 14.2*, 14.3*
14.6*	26	14.4*	26	
App. I*	27		27	14.4*, 14.5
HOLIDAY	28	HOLIDAY	28	HOLIDAY
App. I*	Mar-31	14.5*	Mar-31	
Review	1		1	14.5, 14.6*, Appendix I*
Chapter 14 Test	2	14.6*, Appendix I*	2	
Review	3		3	Appendix I*, Review
15.1*	4	Appendix I*, Review	4	
15.2*	Apr-07	Chapter 14 Test	Apr-07	
15.2*	8		8	Chapter 14 Test, 15.1*
15.3*	9	Review, 15.1*	9	
15.3*	10		10	Review, 15.2*
15.4	11	15.2*	11	
15.5	Apr-14	15.3*	Apr-14	
15.5	15		15	15.3*, 15.4
15.5	16	15.4, 15.5	16	
15.6*	17		17	15.5, 15.6*
15.6*	18	15.6*	18	
App. J*	Apr-21	Appendix J*	Apr-21	
App. G*	22		22	Appendix J*, Appendix G*
App. E	23	Appendix G*	23	
App. E	24		24	Appendix E, Review
Chapter 15 Test	25	Appendix E	25	
Review	Apr-28	Review	Apr-28	
Final/Post Review	29		29	Chapter 15 Test
Final/Post Review	30	Chapter 15 Test	30	
Final/Post Review	May-01		May-01	Final/Post Review
Final/Post Review	2	Final/Post Review	2	
Final/Post Review	May-05	Final/Post Review	May-05	
FINAL EXAMS	6	FINAL EXAMS	6	FINAL EXAMS
FINAL EXAMS	7	FINAL EXAMS	7	FINAL EXAMS
FINAL EXAMS	8	FINAL EXAMS	8	FINAL EXAMS
FINAL EXAMS	9	FINAL EXAMS	9	FINAL EXAMS
LEGEND:				
AT - ASSESSMENT T	REV - REVIEW		REV - REVIEW	
CH - CHAPTER	APP - APPENDICES or APPENDI		APP - APPENDICES or APPENDIX	
* - There is a calculator accompaniment.				

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Contents

APPENDIX C

Table and Corresponding Graph
For
determining Sample Size

Table for Determining Sample Size from a Given Population

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size.
S is sample size.

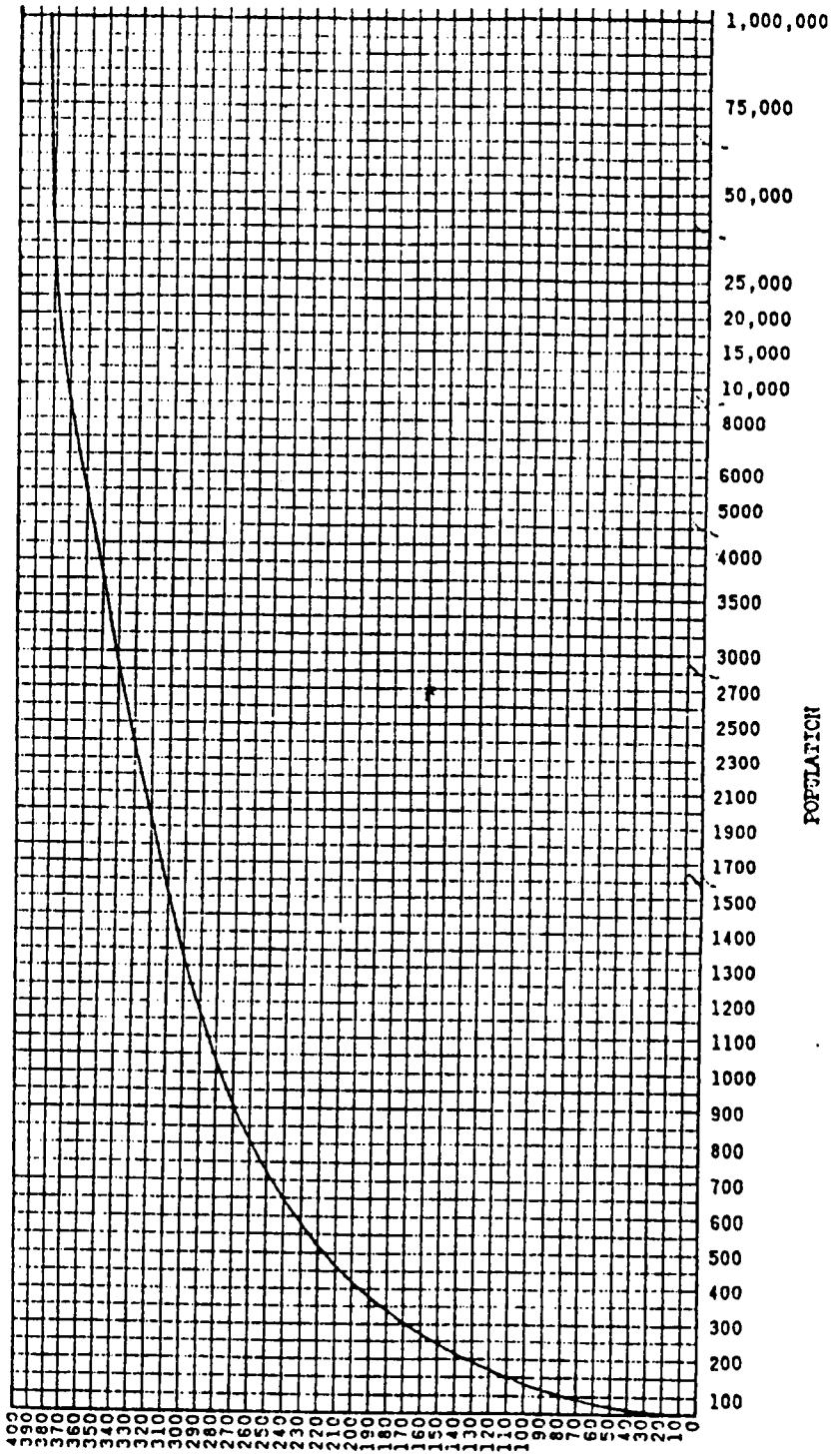

Figure 1. Relationship between sample size and total population

APPENDIX D

Package Used to Share the Survey Results With Students

LEARNING STYLES CHART FOR [redacted]

LEARNING STYLE	LEAST LIKE	MOST LIKE
VISUAL LANGUAGE	= **********	
VISUAL NUMERIC	= **********	
AUDITORY LANGUAGE	= **********	
AUDITORY NUMERIC	= **********	
TACTILE CONCRETE	= **********	
SOCIAL INDIVIDUAL	= **********	
SOCIAL GROUP	= **********	
ORAL EXPRESSIVENESS	= **********	
WRITTEN EXPRESSIVENESS	= **********	
	10 20 30 40	

VISUAL LANGUAGE means that you learn language skills by sight, mainly by reading.

VISUAL NUMERIC means that you do better with numbers when you see them written.

AUDITORY LANGUAGE means that you learn best by listening.

AUDITORY NUMERIC means you are better with numbers when you can hear them spoken.

TACTILE CONCRETE means you are a builder and learn best when you can touch what you are studying.

SOCIAL INDIVIDUAL means you prefer to work on your own.

SOCIAL GROUP means you learn best by interacting with a group.

ORAL EXPRESSIVENESS means how well you express yourself when you talk.

WRITTEN EXPRESSIVENESS means how well you express yourself in writing.

PRESCRIPTIVE INFORMATION FOR [redacted]

3. Use videotapes, audiotapes, lectures, rote oral practice, or class discussions to help student(s) hear information to be learned.

4. Read problems aloud as they are worked. Student(s) will also benefit from discussions of problems and concepts.

5. Student(s) will need some hands-on experience to supplement learning. Have student(s) draw pictures or act out a story. Use physical objects such as blocks to teach math concepts. Use computer software simulations and multimedia programs.

7. Student(s) will need to interact with others in class discussions and group projects. Pair student(s) with others to review for tests.

8 and 9. Student(s) can do written work on about the same level as oral work.

Type description for the Myers-Briggs Type Indicator
compiled by Dr. E. Smith
(Reproduced by Permission)

ENFJ

ENFJs are interpersonally adept, understanding, tolerant, appreciative, and facilitators of good communication. They can arouse support and enthusiasm and express themselves well. They are usually guided by an idealistic vision in which they believe.

CONTRIBUTIONS TO THE ORGANIZATION -strong ideals of how the organization should treat people--enjoy leading and facilitating--encourage cooperation and organizational values--brings things to a fruitful conclusion-orderly.

LEADERSHIP STYLE -lead through personal enthusiasm--responsive to followers' needs--challenge the organization to be congruent with its values-inspire change.

EDUCATIONAL STYLE -enjoy conversation and think best when talking--see goal of college education as learning to get along with different types of people--like literature and theory--achieve through perseverance and hard work--want learning to relate to human values and growth--need harmony to study and to succeed in general--prefer, and often organize, study groups--prefer to write about human interest subjects--would rather talk than write and may want to dictate first drafts than revise final drafts to make it more logical, sequential, and to remove too many personal references.

POTENTIAL PITFALLS -may suffer from blind loyalty and idealization--may sweep problems under the rug to avoid conflict--may favor relationships over the task--take criticism personally and very sensitive to indifference from others--may take too much care of others and not enough of themselves--need to socialize, may interfere with work--may live by others' "shoulds."

SUGGESTIONS FOR DEVELOPMENT -recognize others' limitations--suspend self-criticism and listen more objectively to feedback-rely on family and friends--pay attention to own needs--focus on what is necessary and not necessarily on what makes everybody happy.

CHOOSING A MAJOR -like to decide major and career early--gravitate toward people fields--may consider teaching, ministry, selling, health care or other areas of service and helping.

FINAL THOUGHT -be cautious about saying to ENFJ "that's the way we do things around here," and don't expect ENFJs to hang around in stagnant relationships.

ENFP

ENFPs are enthusiastic, insightful, tireless, and highly imaginative. They can inspire any group of people because their enthusiasm is highly contagious. They never tire of coming up with original possibilities.

CONTRIBUTIONS TO THE ORGANIZATION -focus on possibilities and initiate change--originators--appreciate others.

LEADERSHIP STYLE- lead with energy and enthusiasm--like to be in charge of start-up phase--often become spokespersons for values relating to people--include and support others and pays attention to what motivates them.

EDUCATIONAL STYLE -material must stimulate their imagination--impulsive energy may lead to lack of focus and follow-through to completion--likes complexity and abstractions--express themselves well, especially spontaneously -likes variety of classes and majors--dislikes uninspired routine and avoids details--prefers to study in groups but often doesn't get things done--writes quickly when inspired and may "dash off" first draft after talking out the paper-must push themselves to rewrite later drafts and should edit the first draft for organization, missing logic, and data.

POSSIBLE PITFALLS -may overcommit or move on to new ideas and projects without finishing those already started--may overlook relevant details--may procrastinate--may test limits and rules and sometimes push too far--may "burn out" or develop physical problems--females may be viewed as the most assertive of the types.

SUGGESTIONS FOR DEVELOPMENT -use assertiveness wisely-not impulsively--find some time to be alone--set priorities and learn to say "no"--pay attention to physical needs--make special effort to develop follow-through and ability to focus on details--apply time management skills--stay in creative people focused environment.

CHOOSING A MAJOR -choose no more than two! and stick to them--need careers where they can initiate new ideas--often in counseling, teaching, arts, journalism, advertising, and sales.

FINAL THOUGHTS -ENFPs are tuned in to the motivations of others and can spend untold hours on interpersonal intrigues and problems--and love every minute of it!

ENTJ

ENTJs -are logical, structured, objective, and decisive about what they view as conceptually valid. They are natural leaders and are frank and logical. They sometimes even appear more confident than their experience can support.

CONTRIBUTIONS TO THE ORGANIZATION -develop well thought-out plans and provide structure--take charge quickly and deal directly with problems caused by confusion and inefficiency.

LEADERSHIP STYLE -have action-oriented energetic approach and long-range vision--manage directly and can be tough when necessary--enjoy complex problems.

EDUCATIONAL STYLE -want material presented clearly--interested in models and systems--uses knowledge to make things happen--follow tightly developed study schedule--will organize study groups and keeps everyone on task--like to read practical material--write first drafts from a brief outline--revise final drafts by expansion of ideas and qualifications of overly blunt statements.

POSSIBLE PITFALLS -focus so much on task that they may overlook other's needs--may overlook practical restraints and considerations--make quick decisions so may appear dominant and impatient--may ignore and suppress own feelings--frustrated by others not as dependable and prompt as they are--sometimes impatient with resistance or questioning of their plans--puts excessive pressure on self.

SUGGESTIONS FOR DEVELOPMENT -be on the lookout for signs of stress--be willing to rethink decisions and gather more information--listen to others--work in recreational activity--pay attention to needs of others--learn to identify own values and feelings, especially before making and following through with decisions.

CHOOSING A MAJOR -tend to decide early and remain confident of choice--enjoy competition and challenge--attracted to management in school, business, science, or health professions.

FINAL THOUGHTS -ENTJs expect a great deal from their mates. A career wife may not be appealing to an ENTJ male. ENTJ females may find it hard to find a mate who isn't overwhelmed by her strong personality and will.

ENTP

ENTPs -are innovative, individualistic, versatile, analytical, and have entrepreneurial interests. They like change and bring energy and imagination to new projects. Obstacles represent a challenge, and they are confident in their ideas. They like to debate for its own sake. They may neglect routine tasks, however.

CONTRIBUTIONS TO THE ORGANIZATION -provide new ways to do things-take initiative and spur others on--like challenges--provide a conceptual frame of reference.

LEADERSHIP STYLE -encourage independence in others--are naturally assertive--apply logical systems thinking--have compelling reasons for what they want to do--a catalyst between people and systems.

EDUCATIONAL STYLE -like intellectual challenges and autonomy--value competence in diverse areas--learn well through dialogue, critique, and debate--difficulty with necessary details--like to study in groups--heavy readers--talking out first drafts with others works well for you--fill in missing facts and eliminate highly complex and rambling concepts in later drafts.

POTENTIAL PITFALLS -may be competitive and unappreciative of others' input -adapt poorly to standard procedures if not to their liking--can get overwhelmed trying to do it all--overlook early signs of stress in themselves--difficulty setting priorities--commit hastily and/or don't finish projects--may miss other important factors--overlook reality in their enthusiasm.

SUGGESTIONS FOR DEVELOPMENT -pay more attention to here and now-validate and acknowledge input from others--set realistic priorities and deadlines-consider what is important to self and others, not just what is logical--pause to let others ask questions in meetings and interviews.

CHOOSING A MAJOR -wide interests make choosing a major difficult--want creativity and originality--attracted to sciences, journalism, marketing, promotion, invention, trouble-shooting.

FINAL THOUGHT-it helps to apologize beforehand when asking ENTPs to repeat themselves.

ESFJ

ESFJs are helpful, tactful, compassionate, and orderly. They place a high value on harmony and like to put other people at ease. They are popular and are natural hosts and hostesses. They pay attention to even the smallest detail to make people feel welcome.

CONTRIBUTIONS TO THE ORGANIZATION -work well with the team approach -timely and accurate--respect rules and authority-handle day-to-day operations efficiently.

LEADERSHIP STYLE -lead through paying personal attention to others and thereby gain good will--keep people well-informed--set a good example for others--uphold organizational values.

EDUCATIONAL STYLE -think best when talking--want theories and abstractions illustrated with human examples--want to serve others with their learning--complain that college classes are taught only for the better students--can achieve beyond expectations by careful planning and follow-through--prefer organized study groups--may assume that everything they read is authoritative--write first drafts better when they are personalized and can include what they care about-final drafts should start by stating a general thesis and deleting many of the references to what they personally believe in.

POTENTIAL PITFALLS -may avoid conflict and sweep problems under the rug-may not step back beyond preconceptions and see the bigger picture--may assume they know what is best for everybody but also not value their own priorities because of desire to please others--lives too much by "shoulds"--give their all and then disappointed when others don't do the same.

SUGGESTIONS FOR DEVELOPMENT -ask others what they want before trying to help--don't ignore uncomfortable facts--consider logical, global implications of decisions and use "cooling off" period first--learn how to value and manage conflict--always factor in your own personal needs.

CHOOSING A MAJOR -like to have major and career plans settled early-prefer people-oriented fields and serving others such as teaching, ministry, sales, health care, hotel management.

FINAL THOUGHT ESFJs may marry alcoholics or be taken in by charismatic religions.

ESFP

ESFPs are friendly, outgoing, fun-loving, likable, and naturally drawn towards people. They live life to its fullest and are great company. They are very curious about what they can see, hear, and know firsthand, then they adapt to what they've noticed and can get others to adapt.

CONTRIBUTIONS TO THE ORGANIZATION–provide enthusiasm, cooperation, action and excitement–present a positive image of the organization–link people and resources–accept people as they are.

LEADERSHIP STYLE-lead through promoting good will–good crisis managers-ease tense situations by bringing together conflicting sides–can keep focus on immediate problem–facilitate effective interactions.

EDUCATIONAL STYLE-good at remembering numbers of facts and events–prefer first-hand experience over books and lectures and do better in active situations vs. tests–learn by trial and error–few college instructors are their type, so few courses are taught in their style–bored by theory–prefer to study with others–should trust hunches when taking tests–don't read much unless they have to–best way to write is to talk out the idea with someone first–revise final drafts by making language less conversational and shortening paragraphs.

POSSIBLE PITFALLS-overemphasize subjective data–don't look before they leap–too much socializing and not enough attention to task–may get over-involved in close relationships to the detriment of job or studies–don't finish what they start.

SUGGESTIONS FOR DEVELOPMENT-consider campus activities carefully and be sure not to get over-involved–usually have lots of friends, so use them for support and assistance–study with others who can help with organization and focus–learn advanced planning and follow-through–make a special effort to consider logical implications in decision-making.

CHOOSING A MAJOR-try different alternatives and remain open to change–like careers involving direct contact with people–found in health fields, sales, design, entertainment, public relations, transportation, and troubleshooting.

FINAL THOUGHT - ESFPs overriding theme is "performing" and life is a bowl of cherries just about 24 hours a day as long as they don't have to "follow the book."

ESTJ

ESTJs -are logical, analytical, decisive, and tough-minded and are able to organize facts and operations well in advance. They get things done. Their firm standards assist them in running things. Frequently they are campus leaders and prefer traditional leadership styles. With the freedom to be in charge and the cooperation of others, they can accomplish a great deal.

CONTRIBUTIONS TO THE ORGANIZATION -see flaws in advance--critique logically--organize process, products, and people--good monitors of the job-follow through in step-by-step way.

LEADERSHIP STYLE -take charge quickly and directly--apply and adapt past experiences to solve problems--get at core of situation directly--decide quickly-traditional leaders who respect authority.

EDUCATIONAL STYLE -want requirements of course spelled out clearly--prefer step-by-step learning and my have trouble with theory--want material presented clearly and logically--mostly only logic and solid facts will convince them and want to see ideas put into practice--use study schedules effectively--prefer to study with others as long as group stays organized--read just enough to start a project--good speakers and write best by dictating first draft--should revise final drafts by citing theories that underlie the facts.

POSSIBLE PITFALLS -may make hasty decisions--may overlook or not appreciate the need for change and rigidly stick to old methods that are no longer effective--can ignore feelings of self and others and then be overwhelmed by them--can be critical and domineering with little awareness of its impact--can't understand when others' actions are based on anything but logic--difficulty when asked to answer hypothetical questions or make long-term projections.

SUGGESTIONS FOR DEVELOPMENT -consider all sides before deciding and consult with others who may be more attuned to the human element--prod yourself to look at the benefits of change--make special effort to show appreciation of others--take time for self-reflection and awareness of own feelings.

CHOOSING A MAJOR -tend to choose a major early and not question it later--wants immediate and tangible results--attracted to business, production, construction and administration, law enforcement.

FINAL THOUGHT -do not expect ESTJs to have a lot of psychological insight and understanding. For them, the World can only be black and white--subtle shades of gray may be totally lost on them.

ESTP

ESTPs -are good-natured problem solvers whose friendliness leads others to like and listen to them. They are realistic and resourceful and may strive for efficiency by not focusing on details. They had rather give a brief recommendation and then move on to the next problem.

CONTRIBUTIONS TO THE ORGANIZATION -negotiate and find compromises to keep things moving--make things happen--take realistic approach--take risks but remember and use factual information.

LEADERSHIP STYLE -take charge readily in a crisis--direct, assertive, and persuasive--efficient and results oriented--provide for flexibility in doing the job.

EDUCATIONAL STYLE -prefer first-hand experience, and ability will show in actual situations vs. tests--impatient with ideas that can't be tested--not many college instructors are their type--may jump from one subject to another when studying--may organize study groups that turn into play--don't do a lot of non required reading--would rather do than write about something, but can write easier by dictating first drafts then revise drafts by removing excessive data.

POTENTIAL PITFALLS -not natural theoreticians--may be too blunt--impulsive and may lack direction--can get caught up in activity and ignore studies--may sacrifice follow-through to get to next immediate problem--can get hooked by materialism.

SUGGESTIONS FOR DEVELOPMENT -trust hunches but weigh pros and cons before acting--remember others' feelings--find the line between spontaneity and impulsiveness--plan ahead more, stick to it until 100% complete, and look beyond material pleasures.

CHOOSING A MAJOR -often use trial and error--seek part-time work to try out options--like areas requiring action and practicality such as engineering, construction, marketing and sales, production, law enforcement.

FINAL THOUGHT -ESTPs ability to display an uncanny, charismatic magnetic charm, melts down barriers faster than ice on a warm summer day. They seldom build antagonism or grudges but had rather get even then go on with the art of living.

INFJ

INFJs -are often creative. Because of their trust in their own vision, creativity and influence may be expressed quietly. They are usually well-prepared and bring an original flair to their work, either artistic, poetic, or imaginative in some way. They are insightful and seek harmony–have faith in their inner vision and a deeply felt compassion.

CONTRIBUTIONS TO THE ORGANIZATION -provide future oriented insights especially in regard to human needs–follow through on commitments–like jobs requiring solitude and concentration–organize complex interactions between people and tasks.

LEADERSHIP STYLE -lead through vision and win cooperation rather than demand it–quiet yet persistent–inspire others.

EDUCATIONAL STYLE -prefer theory and underlying meaning–independent and willing to challenge authority–study best alone with quiet–express creative ideas in writing–want enthusiastic instructors–should learn to compromise to meet professors' expectations–manage time well–do a lot of non-required reading–write best when able to express their own convictions–should revise final drafts by fitting original ideas to the requirements of the assignment–join campus groups where they can put their ideals into practice or serve others.

POTENTIAL PITFALLS -may be too seclusive or so single-minded that they ignore tasks that need to be done–may be overlooked or not be verbal with their ideas or criticisms–can ignore information contrary to their own convictions–may not express strong expectations of others and not understand others lack of investment–difficulty with following instructions–may avoid networking and not sell self aggressively enough.

CHOOSING A MAJOR -use careful research but trust inner vision–attracted to fields such as teaching, counseling, ministry, science, research, training and development.

FINAL THOUGHT -INFJs need to work for a cause, a leader, a purpose–if it is bigger than life itself, then it's perfect. Life is a drama and should be played to the hilt.

INFP

INFPs are open-minded, idealistic, insightful, and flexible individuals who want their work to contribute to something that matters. They are more deeply invested in what they do than people realize. They are quiet but warm and seek to have personal impact in whatever they do. They notice subtle nuances behind people's words and behavior. While they tend to take on more than seems possible, somehow they do it.

CONTRIBUTIONS TO THE ORGANIZATION -work to find a place for everyone -persuasive about their ideals--draw people around a common purpose--seek new ideas--quietly push for organizational values.

LEADERSHIP STYLE -are facilitators--prefer unique leadership roles vs. traditional ones--work independently--more likely to praise than criticize--encourage others to act on their ideals.

EDUCATIONAL STYLE -like general concepts and original or complex material-value art and writing in expression--read a lot and like literature--want instructors to arouse enthusiasm for learning--need quiet to study--can be surprised by how much more they have to study in college--write best from inner inspiration--draw ideas from diverse sources and show conceptual links--in final drafts should strive to simplify, shorten, and provide factual data to illustrate their points.

POSSIBLE PITFALLS -can be perfectionists and delay completion of tasks because of it--try to please too many people--may spend more time on reflection than action--sense of inadequacy despite the facts--difficulty accepting reality when it contradicts their idealistic vision--trouble with time management and organization.

SUGGESTIONS FOR DEVELOPMENT -learn to be assertive--adjust vision to the facts and logic--use writing to express idealistic vision--learn time management--turn project in when it's time even though it may feel incomplete-trust objective evidence of your performance--develop and implement action plans and learn to work with reality rather than seeking the perfect response.

CHOOSING A MAJOR -want career to contribute to a purpose beyond the paycheck--often found in counseling, ministry, teaching, writing, science, or psychology.

FINAL THOUGHT -eliminate paradoxes and you destroy all the fun for an INFP.

INTJ

INTJs -have independent and original ideas. They are single-minded and determined and trust their vision of possibilities regardless of universal skepticism.

CONTRIBUTIONS TO THE ORGANIZATION -provide strong conceptual and design skills--can organize ideas into action plans--can help remove obstacles to goal attainment--have strong visions of what the organization can be--help organization understand the system as a whole and how the parts interact-conceptualize, design, and build new models.

LEADERSHIP STYLE -drive themselves and others to attain organizational goals--act strongly in the field of ideas--can be tough-minded--willing to relentlessly reorganize the entire system if necessary.

EDUCATIONAL STYLE -seek theory or underlying principle to everything--learn by questioning authority and popular beliefs--love new models--a lot of instructors are their type--learning needs to relate to some larger purpose--may be very studious and prefer to study alone--write by stating a popular position and then challenging it--should revise first drafts by softening overly firm statements, filling in missing facts, and providing human examples.

POSSIBLE PITFALLS -can appear unyielding and intimidating and may ignore their impact on others--criticize others because of their own ideal standards--difficulty giving up impractical ideas--difficulty putting aside work and relaxing-may get caught up in organizing and not get around to implementing--may try to master all subjects--may not share feelings even with close friends.

SUGGESTIONS FOR DEVELOPMENT -work on learning to appreciate others and solicit their feedback and suggestions--involve others in personal life and work on intimacy--schedule time to relax and follow it.

CHOOSING A MAJOR -will research carefully before choosing a major--like autonomy and dislike routine--attracted to sciences, engineering, politics, philosophy, college teaching, and research.

FINAL THOUGHT -expect INTJs to ask "why" to everything and then not even readily accept the answer. Then expect "the Big Chill."

INTP

INTPs are quiet but undying skeptics. They are rational, curious, theoretical, abstract and prefer to organize ideas rather than situations or people. They like new ideas and have little concern for parties or small talk. They can, however, become quite talkative about a topic they've recently studied. Their logic cuts directly to the core issue of any problem.

CONTRIBUTIONS TO AN ORGANIZATION--design logical and complex systems--demonstrate expertise in tackling complex problems--have short and long-range intellectual insight--can apply logic and critical thinking well--cut directly to core issue.

LEADERSHIP STYLE-lead through conceptual analysis of problems and goals-apply logical systems thinking--prefer to lead other independent types--relate to others based on ability rather than position--seek to interact at an intellectual rather than emotional level.

EDUCATIONAL STYLE-intensely curious--abstract learners--understand theories and underlying principles quickly--often are avid readers and can get so absorbed in reading that they forget time and people--hard time studying without quiet for concentration--may not have studied much in high school, so college can be shocking--write first drafts loosely and include all possible related ideas then revise final draft by reducing complexity and including human examples.

POTENTIAL PITFALLS - can be too abstract--unrealistic about necessary follow-through--can be over-intellectual and theoretical in their explanations--get caught up in minor inconsistencies at expense of teamwork--may act impersonally or overly analytical with others--may lack social supports and ignore extracurricular activities--get consumed by subjects they like and ignore all others--may try and read everything on a topic and put off writing.

SUGGESTIONS FOR DEVELOPMENT-work on focusing on practical details and follow-through--try and state things simply--make an effort to show appreciation for other's effort and get to know both their personal and professional style--look beyond logic to see what others and you really care about--work on making social contacts--learn to take breaks for physical and social activity.

CHOOSING A MAJOR-their need to understand everything can make picking a major difficult--focus on pure sciences, math, research, engineering, college teaching, computer analysis, or any field involving theory such as philosophy or psychology.

FINAL THOUGHT-the person who designed the bumper sticker "Question Authority" was probably a die-hard ***INTP.***

ISFJ

ISFJs genuinely care for people and work tirelessly in their behalf. They are sympathetic, loyal, consistent, and dependable. They accept responsibilities beyond the call of duty. When in charge, their practical judgment make them conservative and consistent.

CONTRIBUTIONS TO THE ORGANIZATION--Take people's practical needs into account--have strong follow-through skill--responsible with detail and routine-dependable and willing to serve others.

LEADERSHIP STYLE--may be reluctant to accept leadership at first, but will step in when asked--expect others and themselves to comply with needs, structure, and hierarchy of the organization--use personal influence behind the scenes--use skills for details to reach practical results.

EDUCATIONAL STYLE --likes things clearly stated--can remember and use a number of facts--strive for accuracy--need practical purpose for learning--learn best from human examples--able to achieve beyond tested abilities through painstaking work--prefer to study alone--write best by first recording the facts they are sure of then revise final drafts by highlighting general themes discovered among the facts and eliminating extraneous ones.

POSSIBLE PITFALLS--*ISFJs* who are less assertive, especially females, may lack self-confidence--difficulty with separation from family and friends--may agree to help too many others and can be undervalued because of their quiet style--have to work at being open to other ways of doing things--can come across as not tough-minded enough--may make hasty decisions.

SUGGESTIONS FOR DEVELOPMENT--learn to publicize self--work on seeing the big picture and put less emphasis on facts--learn directness in communication.

CHOOSING A MAJOR--like to research options carefully before deciding--believes in the "ideal job" that will provide a stable and secure future--attracted to human services, especially where they can use an orderly approach such as teaching, health care, or office administration.

FINAL THOUGHT - Insist that others do their jobs and don't try and do it for them.

ISFP

ISFPs are gentle, considerate, and compassionate toward those less fortunate. They are open-minded, flexible, friendly and quiet. They like to avoid disagreements, are modest, and have a quiet sense of humor. Enjoying the present moment fully, they don't want to spoil it with over-exertion.

CONTRIBUTIONS TO THE ORGANIZATION -act to ensure others well-being-bring people and tasks together through their cooperative nature--pay attention to the humanistic aspects of the organization.

LEADERSHIP STYLE -cooperative team approach is preferred--use personal loyalty as a motivator--use praise more than criticism--gently persuade others by tapping into their good intentions.

EDUCATIONAL STYLE -like instructors who are clear but flexible--understand college is for acquiring a basic general education--may underestimate their own potential--not many college instructors are ISFPs, which may cause difficulty-prefer to demonstrate learning through quiet action rather than words--write better when they care about the topic--should revise final drafts by adding a firm conclusion and removing excessive facts or stories.

POTENTIAL PITFALLS -hard to talk about feelings--take themselves for granted--trust too much and criticize too little--need more skeptical analysis--may neglect making a long-term plan--too apt to get hurt and withdraw rather than be assertive.

SUGGESTIONS FOR DEVELOPMENT -develop more future orientation and assertiveness--consider long-term goals--don't ignore uncomfortable facts when making a decision.

CHOOSING A MAJOR -like to keep options open--like service careers but also want to work with hands or in nature--consider health service, accounting, nature, visual and performing arts in "hands-on" setting.

FINAL THOUGHTS -ISFPs have no need to unravel ambiguities, rather they are inclined to ignore them. They must constantly be reminded to read the directions or manual first. Do not be surprised when an ISFP manager has less of a sense of urgency; for them living the here and now is important--the future can wait.

ISTJ

ISTJs -are accurate, painstaking, systematic, and hard working. Bank on ISTJ to provide practical information on a timely basis (if not early). They are among the most reliable and dependable of any group.

CONTRIBUTIONS TO THE ORGANIZATION -steady and on schedule--manage detail well--will honor commitments and work well within organizational structure.

LEADERSHIP STYLE -use experience and knowledge of the facts to make decisions--take position through reliable, stable, and consistent performance--respect traditional, hierarchical approaches--reward those who follow the rules and get the job done--pay attention to practical organizational needs.

EDUCATIONAL STYLE -learn best when following a plan--learn best sequentially--like to master the facts and arrive at generalizations by accumulating them--good time managers when studying and completing projects -study best quietly alone on one project at a time--often are avid readers--write first drafts from an outline of factual information using a familiar format--need to revise first drafts by adding conceptual overview and leaving out extraneous details.

POSSIBLE PITFALLS -can overlook long-range implications and neglect interpersonal niceties--may become inflexible in their ways and thought of as rigid--can get caught in standard operating procedures and thus not encourage innovation in themselves or others--may be too perfectionistic--high school study techniques may not work in college--can miss the fun of college--may work to the point that they neglect their mental and physical health.

SUGGESTIONS FOR DEVELOPMENT -consider the human element and communicate deserved appreciation--stop periodically, step away from the problem and evaluate effectiveness of current method--look for and seek advice about new solutions--learn to skim material when appropriate--outline main points rather than memorizing--when seeking resources, start with close friends and gradually widen network.

CHOOSING A MAJOR -prefer fields where their attention to important details can be useful--like to carefully gather facts before deciding--often choose majors such as accounting, finance, business, law, civil engineering, production, construction, or health administration.

FINAL THOUGHT -the ISTJ is the ultimate "saver" attracted to the ultimate "spender." It won't work for them to be involved with another "Rock of Gibraltar."

ISTP

ISTPs are cool onlookers. They are adept at managing situations, aware of facts, expedient, realistic, and not likely to be convinced by anything but reasoning. They analyze life with detached curiosity and occasional surprising flashes of humor. Inwardly they are organizing the information they gather about their environment.

CONTRIBUTIONS TO THE ORGANIZATION--act as troubleshooters--a walking compendium of information--get things done in spite of the rules, not because of them--remain calm in crises and have calming effect on others--natural talent in technical areas.

LEADERSHIP STYLE-lead by setting example--prefer egalitarian team approach--respond quickly to trouble--manage loosely and want to be managed loosely.

EDUCATIONAL STYLE -always looking for and usually find the underlying principle--want material presented clearly-prefer objective material--few college instructors are their type, so often have difficulty adapting to college teaching style--bring order to unorganized facts when reading or writing--prefer to study alone--enjoy technical material related to solving problems--difficulty writing--first drafts should include their natural wry wit mixed with facts--final drafts should include human examples and should delete all unnecessary facts.

POSSIBLE PITFALLS-may keep important things to themselves and appear unconcerned--may appear indecisive and undirected--tendency to move on before efforts bear fruit--looks for too many shortcuts--tends to underestimate time required for a task--forgets to show appreciation to others.

SUGGESTIONS FOR DEVELOPMENT-open up and share information--develop perseverance--make a habit of setting goals and assessing effort toward them before judging results

CHOOSING A MAJOR-likes to investigate options as long as possible--stable and secure future is important consideration in picking a career--attracted to applied science, mechanical troubleshooting, law and law enforcement, economics, marketing, securities, and statistics.

FINAL THOUGHT - ISTPs often play on impulse and "take off" at any time simply because they "feel like it."

VITA

Azar Raiszadeh graduated from the College of Business Administration in Tehran, Iran in May of 1974. She came to the United States in August of 1974, attending graduate school in Fall of 1975 at the Southeastern Louisiana State University. She received a Master of Business Administration (MBA) degree in May of 1977.

She began her college teaching career at the University of Tennessee at Chattanooga's School of Business Administration in 1983 where she taught statistics, management, marketing, and economics till 1991. Meanwhile, she taught mathematics at Girls Preparatory School in Chattanooga, Tennessee from 1986 to 1989. She also taught mathematics and statistics at Chattanooga State Technical Community College (CSTCC) as an adjunct faculty from 1990 until 1993. She assumed a full time teaching position in 1993 in the Developmental Mathematics Department at CSTCC, where she is presently employed. Azar started the doctoral program at the University of Tennessee at Knoxville in the Spring of 1994 and graduated in the Fall of 1997.

Azar is married to Farhad Raiszadeh who is a professor of Management at the University of Tennessee at Chattanooga. They have two children, Katty and Nillo.