INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

UMI

A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor MI 48106-1346 USA
313/761-4700 800/521-0600

Characterizing the Successful Student in General Chemistry and Physical Science Classes in Terms of Jung's Personality Types as Identified by the Myers-Briggs Type Indicator

Wayne David Riley

A Dissertation submitted to the
Graduate Faculty of Middle Tennessee State University
in partial fulfillment of the requirements
for the degree Doctor of the Arts
August 1998

Characterizing the Successful Student in General Chemistry and Physical Science Classes in Terms of Jung's Personality Types as Identified by the Myers-Briggs Type Indicator

Wayne D. Riley

Approved:

Major Professor

Reader

Reader

Reader

Department Chair

Dean, College of Graduate Studies

ABSTRACT

Characterizing the Successful Student in General Chemistry and Physical Science Classes in Terms of Jung's Personality Types as Identified by the Myers-Briggs Type Indicator

A student's success in a science class can depend upon previous experiences, motivation, and the level of interest in the subject. Since psychological type is intrinsic to a person's whole being, it can be influential upon the student's motivation and interests. Thus, a study of student psychological types versus the level of success in a class, as measured by a percentage, has potential to uncover certain personality characteristics which may be helpful to or which may hinder a student's learning environment. This study was initiated, using the Myers-Briggs Type Indicator, to evaluate any correlation between a student's personality type and his/her performance in a science class. A total of 1041 students from three classes: Chemistry 121/122, Chemistry 112, Physical Science 100, volunteered for the study. An analysis of variance (ANOVA) was used to determine the levels of significance among sixteen personality types' averages. The results reveal that for the Chemistry 121/122 course, the average score of the INTJ personality type was 5.1 to 12.6 points higher than every other personality type. The ANOVA identifies 3 personality types with averages significantly below the INTJ at the $p < 0.05$ significance level and 11 personality types significantly below at the $p < 0.01$

significance level. The ANOVA analysis for the Chemistry 112 course identified significances between student scores at $p = 0.08$. The significance level for the differences among scores for the Physical Science 100 course was determined at a level of $p = 0.02$. Significance levels for $p < 0.05$ and < 0.01 were identified between several groups in this course. The data suggest, that although personality type may not predict a particular student's success in a science class, students with certain personality traits may be favored in a chemistry class due the structure of the instruction and the presentation of the subject matter.

ACKNOWLEDGEMENTS

Several people have given me a share of their time during the preparation of this dissertation. Therefore, it would not be complete unless they were recognized in its initial pages. Dr. Mary McCaulley and the Center for Application of Psychological Types of Gainesville, Florida provided financial assistance with the Myers-Briggs Type Indicator computer scanned results. My gratitude to the Graduate School of Middle Tennesse State University for providing to me a generous fellowship which allowed me to concentrate solely on the work for this dissertation. Dr. Tom G. Filloon of Proctor and Gamble and Dr. C.K. Fuchs of Middle Tennessee State University provided their valuable expertise with advice in intrepretation of the statistics. My sincerest thanks to my committee members, Dr. Gale J. Clark, Dr. Edwin Woods, Dr. Nancy Keese, and Dr. Ralph Ballou for believing in this work and indulging me in many hours of conversation which allowed me to generate and polish the ideas presented in this dissertation. A special thanks to Dr. Keese for joining my committee during the final stages of the work. My appreciation to Dr. Jane L. Williams for her tolerance of my questions about everything which is accepted and practiced in the field of education and to Dr. Karen Huggins, who happened to be at the right place at the right time. Finally, all my love and deepest thanks to my family, especially my mother. Theresa, who has a big heart and a lot of faith.

Table of Contents

Chapter Page

LIST OF TABLES

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

THE RESEARCH

Introduction

Felder (*1*) acknowledges that the classroom is becoming problematic as professors face unresponsive or hostile classes, poor attendance and dropouts, and low test scores. This educator also suggests several negative responses to these problems as instructors may begin to criticize the student or blame themselves, leading to a loss of many proficient teachers as they leave for other professions. Felder continues to explore the possibility that one answer to this problem may be found in developing an understanding of learning and teaching styles. He believes that it is this mismatch between learning styles and traditional teaching styles that creates bored and inattentive students, who eventually get discouraged with the course and curriculum as their poor test scores do not add up to a passing grade.

In her study on science classes at the collegiate level, Tobias (*2*) recognizes a type of student that she describes as second tiered. A second tiered student is characterized as having the intelligence to understand scientific material but instead has chosen an alternative field. In some cases, many of these second tiered students started their college years with an interest in science but instead have followed a path into other areas of study.

Tobias asked 'second tiered' students to describe in a journal their thoughts and feelings as they participated as a graduate student in an undergraduate science course (usually physics or chemistry). Typical results from the group of participants were: 1) experienced a competitive spirit among the students that was felt as having negative implications; 2) professors did not seem to acknowledge students as unique individuals; too much work compared to their other courses; and 3) too much theory with no relative examples in everyday life.

Certainly, it was very likely that other students found the same classes exciting and challenging, and it would not be surprising if such students finished their studies as science majors. But, what can be made of the negative experiences of the students who participated in the study? Could the many factors involved in learning a subject create a positive experience for some and a negative experience for others? In addition, could these differences be due to idiosyncratic preferences and differences in individual methods used to make decisions? Myers and McCaulley (*3*, p. 77) explain a similar experience of choosing a career where the work is motivating and interesting. They believe that the underlying reason for career satisfaction is due to the various tasks and components of a career that call on the kinds of perception and judgment preferred by individuals.

The Concept of Individual Learning Styles

The study of learning styles has been a growing field with active research being conducted at over 60 universities during the 1980s (*4*). The initial seed of research in learning styles may, however, have been sown as far back as the early 1900s with the work of Edward L. Thorndike. In concluding his book on the individuality of the student, Thorndike (*5*, p. 51) emphasizes that treating a group of pupils in exactly the same manner would fall short of maximizing each student's potential.

The understanding of the link between individuals' uniqueness and their developing learning styles is explained by Dunn, *et al.* (*4*). These authors state that most students have the ability to master the same material; however, the difference is found in *how* they master it. And *how* students master the material is in reality a factor of students' learning styles. The connection between Dunn and Thorndike's work is that students learn best when specialized instruction is in tune with their individual learning style. Creating this specialized instruction based on various learning styles is in fact a responsibility assumed by every teacher. Anyone suggesting that a pupil should be forced to adapt another's learning style or teaching style is admonished by Dunn for not understanding the true biological nature of style. Thus, recognizing students' learning styles should be prerequisite to designing meaningful and effective instructional materials for all students.

Carl G. Jung (*6*) presented a theory on individuality in which he defined

the term 'psychological type' to describe observed differences among people. The link between Jung's research and learning styles is cited in many current publications. Schuells (*7*) suggests two subcategories which have been the basis for extensive recent research in the field of individual learning styles: mental abilities and personality types. This author does not go into further detail concerning the assessment of personality types, but several other authors mention Jung when illustrating characteristics of learning styles. Barger and Hoover (*8*) believe that learning style or cognitive style is synonymous with personality type. Meisgeier and Murphy (*9*) connect psychological types identified in children to the way in which they absorb information, organize thoughts, and finally make decisions. Fourqurean's, *et al.*, (*10*) studies showed a positive correlation between learning styles and Jung's psychological types. These works form a basis which suggests that the theories of Jung's personality types may be used as a tool to assist in solving the classroom problems that troubled Felder.

Personality Types as They Define Decisions and Actions

It may be coincidental, or as Jung might describe it, synchronistic, that Thorndike on page 1 of his book, **Individuality** (*5*), foreshadows Jung's theories of personality types through the use of the words, feel, think and act in the quote "...it would be necessary... to state in each case how he (man) would **feel** and **think** and **act** in response to that happening." These words by

both men are used in very similar contexts positing the process which a person uses to make a decision leading to an action.

Jung argued that the patterns of decisions that people exhibit are not random and thus can be categorized. Over 70 years ago he studied these patterns and suggested three categories which described individual decision making. Jung described three essential factors involved in making a decision: 1) the gathering of pertinent data, 2) the interaction with an object which the decision usually affects, and 3) the making of the decision. Jung called the first category of collecting data the perception function (described as irrational as contrasted to the rational, judging function); the making of the decision as the judging function (the rational function); and the involvement with the object, the attitude. One modern instrument used to evaluate these factors in individuals, the Myers-Briggs Types Indicator (MBTI), provides data on a fourth category. The fourth category's purpose is to objectively identifying which function, the rational or the irrational, would be the individual's dominant function (Jung was able to decide the patient's dominant function through a personal analysis of the subject). The MBTI will be discussed later in this chapter.

Each category consists of bipolar components. The perception function consists of ***sensing*** (perceptions observable through the five senses) or ***intuitive*** (perceptions of possibilities, meanings, and relationships by way of insight.) The 'sensing type' (S) best relates to facts and observations, while

the 'intuition type' (N) prefers theory, imagination, and intuition. The judging function consists of ***thinking*** (the linking of ideas through logical connections) or ***feeling*** (reaching decisions by consideration of relative values and merits.) The 'thinking type' (T) likes rules, logic, and order while the 'feeling type' (F) weighs the consequences with the action and considers priorities and relative degrees of importance.

The attitudes are described by extraversion and introversion. A person who generally considers the effects of a decision on objects in their environment is described as ***extraverted*** (E), while those who reach decisions by looking inward and who try to understand the world and its workings possess the ***introverted*** (I) attitude. The fourth category, or the individual's outer world orientation, is denoted by either ***judging*** (J) or ***perceiving*** (P). Generally, judging types are concerned with making decisions, seeking closure, planning or organization, while the perceiving types may be concerned with incoming information, are open, curious, and interested in objects. This category indicates which function would be used when an individual deals their external world, i.e., when they are extraverting. For an E type this would then be their dominant; for an I type their dominant would be the other function. For example, an ENTP would exhibit the perceiving function externally which is N, and since they are extraverted this is their dominant function. For an INTP, they would exhibit the N function when dealing with their external surroundings, but because they are

introverted this would not be their dominant function. Their dominant function would be thinking (T).

The four bipolar categories produce 16 personality type combinations (Figure 1). (Jung used the term *psychological type*. The term *personality type* will be used throughout this dissertation as a convenience.) These 16 types describe in general ways how people interact with the world and confront various situations. An identified personality type does not label an individual's methods of interaction. Their actions are neither good nor bad, intelligent nor simple-minded, positive nor negative; they just are. Although the types do not label an individual, they, instead, may provide some basis for characterizing specific influential features which affect decisions and handling difficult tasks or frustrating situations encountered moment by moment by individuals.

Jung believed that individuals develop their personality type by the age of 6 or 7. By this age, the dominant and auxiliary types are set for all individuals. In situations, particularly those which are perceived to be stressful or unfamiliar, individuals will call upon their dominant and auxiliary types with the dominant type the one most favored. An excellent way of understanding this is by the example of handedness. Each of us is either right- or left-handed, and this preference is used to strike or pull if control is needed (i.e. writing our names). Yet we can use either hand to move or grasp objects for general or non demanding tasks.

ISTJ Analytical Manager of facts and details, dependable,decisive, painstaking and systematic; concerned with systems and organization; stable and conservative	**ISFJ** Sympathetic Manager of facts and details, concerned with people's welfare; dependable, painstaking and systematic; stable and conservative
ISTP Practical analyzer; values exactness; more interested in organizing data than situations or people; reflective, a cool and curios observer of life.	**ISFP** Observant, loyal helper; reflective, realistic, empathic; patient with details, gentle and retiring; shuns disagreements; enjoys the moment.
ESTP Realistic adapter in the world of material things; good natured, tolerant, easy going; oriented to practical, first hand experience, highly observant of details of things.	**ESFP** Realistic adapter in human relationships; friendly and easy with people; highly observant of their feelings and needs; oriented to practical, first hand experience.
ESTJ Fact-minded, practical organizer; assertive, analytical, systematic; pushes to get things done and working smoothly and efficiently.	**ESFJ** Practical harmonizer and worker-with-people; sociable, orderly, opinioned; conscientious, realistic and well tuned to the here and now.

Figure 1. The Sixteen Types' General Descriptions and Characteristics. © CAPT(used with permission).

INFJ People-oriented innovator of ideas; serious, quietly forceful and persevering; concerned with the common good, with helping others develop.	**INTJ** Logical, critical, decisive innovator of ideas; serious, intent, highly independent, concerned with organization; determined and often stubborn.
INFP Imaginative, independent helper; reflective, inquisitive, empathic, loyal to ideals; more interested in possibilities than practicalities.	**INTP** Inquisitive analyzer; reflective, independent, curious, more interested in organizing ideas than situations or people.
ENFP Warmly enthusiastic planner of change; imaginative, individualistic; pursues inspiration with impulsive energy; seeks to understand and inspire others.	**ENTP** Inventive, analytical planner of change; enthusiastic and independent; pursues inspiration with impulsive energy; seeks to understand and inspire others.
ENFJ Imaginative harmonizer and worker-with-people; sociable, expressive, orderly, opinioned, conscientious; curious about new ideas and possibilities.	**ENTJ** Intuitive, innovative organizer; analytical, systematic, confident; pushes to get action on new ideas and challenges.

Figure 1 (continued). The Sixteen Types' General Descriptions and Characteristics. © CAPT(used with permission).

Jung (*11*) gives an example of the interplay between two different personality types in a story about two boys, one an introvert the other an extravert, who while walking in the country chanced upon a castle.

> 'They come to a fine castle: both want to see inside it. The introvert says, "I'd like to know what it's like inside." The extravert answers, "Right, let's go in,"and makes for the gateway. The introvert draws back - "Perhaps we aren't allowed in," says he, with visions of policemen, fines and fierce dogs in the background. Whereupon the extravert answers, "Well, we can ask. They'll let us in all right" - with visions of kindly old watchmen, hospitable seigneurs, and the possibility of romantic adventures. On the strength of extraverted optimism they at length find themselves in the castle. But now comes the denouement. The castle has been rebuilt inside, and contains nothing but a couple of rooms with a collection of old manuscripts. As it happens, old manuscripts are the chief joy of the introverted youth. Hardly has he caught sight of them when he becomes as one transformed. He loses himself in contemplations of the treasures, uttering cries of enthusiasm. He engages the keeper in conversation so as to extract from him as much information as possible, and when the result is meager the youth asks to see the curator in order to propound his questions to him. His shyness has vanished, objects have taken on a seductive glamour, and the world wears a new face. But meanwhile the spirits of the extraverted youth are ebbing lower and lower. His face grows longer and he begins to yawn. No kindly watchmen are forthcoming here, no knightly hospitality, not a trace of romantic adventure - only a castle made over into a museum. There are manuscripts enough to be seen at home. While the enthusiasm of the one rises, the spirits of the other fall, the castle bores him, the manuscripts remind him of a library, library is associated with university, university with studies and menacing examinations. Gradually a veil of gloom descends over the once so interesting and enticing castle. The object becomes negative. "Isn't it marvelous," cries the introvert, "to have stumbled on this wonderful collection?" "The place bores me to extinction," replies the other with undisguised ill humor. This annoys the introvert who secretly vows never again to go rambling with an extravert. The latter is annoyed with the other's annoyance, and he thinks to himself that he always knew the fellow was an inconsiderate egotist who would, in his own selfish interest, waste all the lovely spring day that could be enjoyed so much better out of doors.'

The preceding story is only a hypothetical example of how individuals' actions and thoughts can be influenced by their personality types. There are,

however, many written accounts of the behavior of very famous scientists which could be described in terms of Jung's personality types. In his essay *The Nature of Newton's Insight*, Jacob Bronowski (*12)* describes the differences between the two great thinkers, Descartes and Bacon, as one possessing the rational, the other exemplifying the empirical approach in science. The method of logic is attributed to Descartes, and the method of experiment to Francis Bacon. Bronowski suggests that the differences in the approach to scientific study is linked to the nationality of each, the French Descartes and the English Bacon, but the difference may be better understood in the context of each man's dominant irrational function, sensing or intuitive. Descartes, the deducer who starts from first principles, exemplifies the intuitive approach to solving a problem; whereas, Bacon, the hands on experimenter and observer inductor, deals with only the science that he can observe through his senses.

Other literature contains indirect descriptions suggesting the influence of type on the idiosyncrasies of several great scientists. J. Woodhull (*13*) (from a speech given by Professor Tyndall in the scientist's honor) describes Michael Faraday as one scientist who never worked from the experiments of others, however clearly described. Faraday knew that each experiment issues forth a unique radiation, luminous to different degrees for each individual. This description shows a Faraday who was enjoying each individual discovery through his own senses, quite possibly showing off his dominant sensing

function.

In **The Tao of Physics**, Capra (*14*) mentions that Einstein's initial thoughts on relativity began as a teenager when he tried to imagine what one could experience if one were able to ride along on a wavelength of light as it traveled through space. Einstein's work was clearly anchored in his fertile imagination based on his strong intuitive irrational function.

An excellent example in using the rational functions of thinking and feeling can be found in an essay by Betrand de Jouvenel on *The Political Consequences of The Rise of Science* (*15*). In this excerpt, Jouvenel even uses the description of the rational function of feeling.

> Let the scientist and the politician both "feel" that "if *A*, then *B*." The scientist would be unworthy of his calling if he did not spend the utmost care upon checking this hypothesis. But the statesman is in quite another position: a decision must be taken in time, and the more value the politician sets on *B*, the greater his anxiety to get done what procures *B*. He "feels" that this is *A*, and therefore is eager to procure *A*'s acceptance. But he would fail therein if he said: "As *B* is of great value, and *A* has some likelihood of bringing it about, therefore let us do *A*." He is driven to assert that *A* shall yield *B*, thus transforming a value judgment on *B* into a certainty judgment on the *A*-*B* relationship. This we could not tolerate in a scientist. We accept it in a politician, pleased enough if he does not cheat us into accepting the *A* he wants for its own sake, by an empty promise that is the way to the *B* we want.

Jung's theory, as described by Myers and McCaulley (*3*, p.12,) is based on the premise that each individual uses four mental processes or functions. Pairings of the rational and the irrational functions relate to *what* is given attention in a given situation and also *how* conclusions are drawn from the incoming perceptions. For example, McCaulley (*16*) describes the

combination of sensing-thinking as found in people who are 'practical and matter-of-fact', preferring to deal with things that are tangible and real and work in line with logical principles. The sensing-feeling types prefer to deal with immediate realities and perhaps would emphasize the 'human' side of a problem. The intuitive-feeling types tend to be the 'enthusiastic and insightful' types while the 'logical and ingenious' person is typical of the intuitive-thinking types. Figure 2 displays these four combinations with their general preferences for job skills and fields of study.

Generally, introverted types seek privacy, solitude, and contemplative detachment while extraverts engage in group discussions, are action-orientated, and social. Character traits of the INTJ type would include introvert, intuitive, thinking, and judging. They would be logical and intuitive and tend to seek knowledge for its own sake, bringing things to conclusion quickly. If the person is more sensing (ISTJ) than intuitive, then there is a tendency to use facts and technical skills over theory. These two examples may describe chemists, physicists, or mathematicians (INTJs) or practicing engineers, accountants, or business people (ISTJs).

The Myers-Briggs Type Indicator

The Myers-Briggs Type Indicator and the Gray-Wheelwright Jungian Type Survey are the two most commonly accepted instruments for measuring Jung's psychological types (*10*). The MBTI, in one of two formats, has been

Sensing Plus Thinking	Sensing Plus Feeling	Intuition Plus Feeling	Intuition Plus Thinking
ST	**SF**	**NF**	**NT**
Practical and Matter-of-fact	Sympathetic and Matter-of-fact	Enthusiastic and Insightful	Theoretical & technical developments
Like using abilities in	*Like using abilities in*	*Like using abilities in*	*Like using abilities in*
Technical skills with facts and objects	Practical help and services for people	Understanding & communicating with people	Logical and Ingenious
for example	*for example*	*for example*	*for example*
Applied Sciences Business Production Construction and more	Patient Care Community Service Sales Teaching and more	Behavior Sciences Research Literature & Art Teaching and more	Physical Sciences Research Management Forecasts, Analysis and more

Figure 2. The Four Combinations of the Perception and Judgment Functions. © CAPT (used with permission)

used in over 4800 studies, mainly in the areas of education and psychology. Its reliability for identifying individual personality types has been proven using the internal split test method (*3*, Chapter 10). Several researchers have studied the correlations of the MBTI functions to accepted psychological evaluations which identify similar personality characteristics, i.e., gregariousness for extraversion and have found the correlations sufficient (*3*, Chapter 11). A study comparing the MBTI to the Gray-Wheelwright Jungian Type Survey has shown a high correlation between the two with the exception of the fourth category found in the MBTI (*3*, p. 209). This finding should be expected since the Gray-Wheelwright Jungian Type Survey does not have such a category.

The MBTI was conceived and designed by Isabel Briggs Myers and her mother, Katharine Myers. Originally published in 1962 by the Educational Testing Service, the MBTI's publishing rights were transferred to Consulting Psychologists Press in 1975.

Previous Studies Using the MBTI

According to data from the MBTI database the 16 types are not equally distributed among the population. Lawrence (*17*) states the general percentages found by I. Briggs Myers and M. McCaulley from data sets of students and adults as:

Extraversion 67%.....Introversion 33%

Sensing 67%.....Intuition 33%

Thinking (female) 33%.....Feeling (female) 67%

Thinking (male) 60%.....Feeling (male) 40%

Judgment 55%.....Perception 45%

Using these data one can calculate the average percentage of each type found in the population. Figure 3 shows the percentage of types in the general population via a type table. Lawrence reported that Myers and McCaulley found a shift in college population of the extraverted/introverted and sensing/intuition categories closer to a fifty-fifty distribution.

Consistent with the Center for Applications of Psychological Types, a type table is constructed consisting of four by four cells to elucidate the distribution of each type. Certain protocols are followed when constructing a type table. This provides consistency among research literature containing type tables. Each type is placed in the figure according to the following guidelines: 1) introverts occupy the top two rows and extraverts the bottom two; 2) sensing types are found in the left two rows and intuitive types in the right two rows; 3) thinking types are placed on the outside two columns with the feeling types on the inside two columns; and 4) the judging preference types are positioned on the top and bottom rows with the perceiving types in between.

N = 10000

ISTJ N=860 %=8.6	**ISFJ** N=860 %=8.6	**INFJ** N= 430 %=4.3	**INTJ** N=430 %=4.3
ISTP N=580 %=5.8	**ISFP** N=580 %=5.8	**INFP** N=280 %=2.8	**INTP** N=280 %=2.8
ESTP N=780 %=7.8	**ESFP** N=780 %=7.8	**ENFP** N=380 %=3.8	**ENTP** N=380 %=3.8
ESTJ N=1150 %=11.5	**ESFJ** N=1150 %=11.5	**ENFJ** N=560 %=5.6	**ENTJ** N=560 %=5.6

Figure 3. Estimated Type Table for General Population.

Studies by McCaulley (*16*) found in a sampling of University of Florida students participating in a two year longitudinal study after matriculation that NT types were significantly more attracted to engineering and the physical sciences while SF types tended more towards nursing and education. The humanities and behavioral sciences were typically favored by the NF types, and ST individuals seemed to favor the biological sciences. Other preference studies based on pairings of the categories showed that the 'academic' IN types were highly represented in the humanities, physical sciences, and engineering while the 'pragmatic' ES types tended to study in such disciplines as physical education, nursing and business. It was also evident that the IS types avoided the physical sciences and tended to choose the biological sciences, with the EN types finding their way into the behavioral sciences. Although certain characteristic types may be found in each discipline, McCaulley emphasizes the point that each type has the intelligence to learn science and that it is dangerous to assume that any particular type may make a poor scientist based on the fact that his or her type is under represented in the scientific fields.

Early work done with correlations of the MBTI and academic performance goes back into the 1960s and 1970s with Myers and McCaulley (*3,* Chapter 8*)*. This early work consisted of correlating IQ and SAT scores with the 16 types. The Myers' studies included mostly males entering the prestigious colleges of Dartmouth, Brown, Amherst, Stanford, Wesleyan and

Pembroke. Students from the University of Florida were evaluated in the McCaulley study. The conclusion was similar in each study: higher IQ or SAT (math or verbal) scores were found with IN and sometimes T types at statistically significant levels. Similar results for NTs, based on 1,616 students' SAT scores, were found at California Institute of Technology (*18*).

The **Manual: A Guide to the Development and Use of the Myers-Briggs Type Indicator** (*3*) contains more data from other studies, i.e., correlating types with high school students' preferences for college studies and medical students' scholastic performances. However, limited studies exist in evaluating personality type related to performance in science classes and these are discussed in the following paragraphs.

The studies of Melear and Tharp describe attempts to relate the 16 types to performance in college level life-science classes. Melear (*19*) used the MBTI to study the types of 673 non major biology students at Ohio State University. The findings showed that the typical non major student could be described as an ESFP type while the science major was more inclined to be an INTJ type. The study's focus was to identify the typical type differences between biology and non biology majors, yet some scholastic performance was evaluated. In an introductory biology course designed for non major biology students, the EP type students received the lowest grades. The data showed that a higher percentage of ESFP and ENTP types received a cumulative test score below 60. It was shown that one type, the ISFP, was twice as likely to

score above a 60. In looking at the students who withdrew from the class by the second week, the distribution of types revealed that 3 groups accounted for almost half of the withdrawals: ISFJ (14.8%), ESTP (18.5%) and ENFP (14.8%).

At the University of Nebraska G. Tharp (*20,21*) completed two studies with students in a human physiology and a general biology course. In the 1992 study of the physiology students, the data showed that the highest achievers were IJ types with EP students being the lowest achievers and also having the highest drop out rate. In the 1993 study of 146 students in an introductory biology course, the data once again showed that IJ students outperformed EP types, INJ bettered ESP types, IS outscored both the ES and EN types and SJ scored higher than NT types. It is noteworthy that in these three relatively recent studies it appears common for EP personality types to be found having the most difficulty with science classes. Tharp concluded that the introductory science courses appear to favor the students who like to work individually on prescribed tasks in a planned, orderly manner, with definite goals and deadlines. This description relates to the IJ type. Those who like to work with other people on real problems in a more informal and flexible learning environment would be at a disadvantage due their learning styles. The EP type would be the example of a student who would exhibit this type of learning style.

A unique distribution of the 16 types is encountered for sets of

university faculty (Figure 4). Lawrence reported that although each of the 16 types are represented in higher education, the NT types are found in higher percentages. Lecturing at Yale University, D. MacKinnon (*22*) stated that it is common to find high percentages of N types among those who teach the theoretical sciences and high percentages of T types in areas of mathematics, engineering, and physical science. He also found that many scientists have a tendency towards control and regulation, which are J type characteristics. Only those rare few who were classified as truly creative were found by MacKinnon to be of the perceiving type.

Purpose of the Study

The combination of the results from the literature cited suggests many possible relationships between learning styles, personality types, and the degree of success experienced by students in academic pursuits. However, no data have been published specifically relating student's performance in a chemistry class to individual personality.

This study was performed to reveal the relationship between a student's performance in introductory university level chemistry and physical science classes and their personality type based on Jungian theory.

ISTJ %=12.8	**ISFJ** %=6.1	**INFJ** %=7.5	**INTJ** %=10.9
ISTP %=1.7	**ISFP** %=1.7	**INFP** %=8.1	**INTP** %=5.4
ESTP %=1.2	**ESFP** %=1.7	**ENFP** %=9.1	**ENTP** %=5.3
ESTJ %=6.5	**ESFJ** %=4.4	**ENFJ** %=8.0	**ENTJ** %=9.6

Figure 4. Percent Distribution of Types Found Among University Professors.

Significance of the Study

A substantial number of students fail or withdraw from an introductory level chemistry course. This leads to a considerable amount of time lost since many students will have to repeat these introductory courses. Identifying differences in students which are related to learning styles may provide a basis for improving instructional methods. Improved methods based on this new understanding may motivate students to work harder and find more enjoyment in a course that they might normally find frustratingly difficult.

Statements of Hypothesis

With regard to the previously sited literature, the hypothesis of this investigation was to expect differences in performance between some personality types. The two variables of interest in this study are student personality type (independent) and student final percent grade (dependent). In order to enable a systematic statistical analysis the following (null) hypothesis will be considered.

Hypothesis:

There will be no significant differences in percent grades within a course based on personality type.

Scope and Delimitations of the Study

This study was limited to students enrolled at Middle Tennessee State University (MTSU) during the Fall 1996, Spring 1997, and the Fall 1997 semesters. Three courses were chosen for the study because they were all introductory level science courses offered by the Chemistry Department. The number of students participating in the study was determined by the enrollment in each of the course sections. Choices as to which Physical Science 100 classes were chosen for inclusion depended on three factors: 1) if the section was taught by an instructor associated with the MTSU Chemistry Department, 2) class enrollment size, and 3) a preset level of funding.

Assumptions

The researcher assumed: 1) that each student understood the questions in the MBTI, 2) gave honest responses and, 3) each instructor covered the material outlined in the course's syllabus.

CHAPTER 2

METHODS and PROCEDURES

A causal-comparative research design (*23*) is used to explore possible cause and effect relationships in situations where it is unethical or impossible to manipulate the independent variable. In this study the independent variable, personality type, could not be controlled, but it is hypothesised that the dependent variable, percent score may be linked to it. Therefore, this study was deigned to determine the relative strength of the relationship between personality type and percent score in a science class.

Sample

Middle Tennessee State University (MTSU) is the third largest public higher education institution in Tennessee. MTSU has 6 colleges: Graduate Studies, Basic and Applied Sciences, Business, Mass Communication, Education, and Liberal Arts. It is a regional university which enrolled approximately 17,300 students, 1,200 from out-of-state or out-of-country, during the 1997-1998 academic year. The average student is 25 years of age and has an ACT score of 22.

To accomplish the goal of including a heterogeneous group of students

spanning the spectrum of various interests and skills, three distinct science courses were identified for inclusion in the study. A total of 1,041 students were surveyed from these classes. Another 28 students in the Honors Chemistry 121H class were included as a special interest group and the chemistry faculty were also surveyed for another 24 participants. An additional 44 students were surveyed in two other classes for a total of 1085 in the MTSU sample.

MTSU provides two lower division chemistry classes in the 100 level sequence, Chemistry 111/112 and Chemistry 121/122. Chemistry 111/112 is designed as a terminal sequence for students who are most often not required to take any additional chemistry courses. The sequence is specifically offered for nursing students, nutrition majors, and some science education majors for instruction in basic chemical principles and organic chemistry. The second semester Chemistry 112 section primarily focuses on organic and biochemistry. This course provided a desired diversification of students compared to against the Chemistry 121/122 course. Three semesters of classes were used in the study to ensure an adequate sample. A total of 241 students from seven sections of Chemistry 112 were included in this study.

Chemistry 121/122 is required of chemistry majors, premed students and other science majors. The majority of the students participating in this study were enrolled in seven 121 sections with two sections of Chemistry 122 bringing the total to 407. During the second semester of the study, only

students from Chemistry 121 participated as the Chemistry 122 students had completed the survey the previous semester in Chemistry 121.

The third set of 365 students was enrolled in Physical Science 100 course over two semesters. This course contains material from a variety of sciences such as chemistry, physics, earth science, and astronomy. The MTSU student population may choose this course to fulfill one of the general science elective requirements.

Instrumentation

Personality types were determined by administering the Myers-Briggs Type Indicator (MBTI) which is available in three formats. The standard form for research is the Form G which is a self-report instrument consisting of 126 questions. It can be computer scored by CAPT or hand scored via overlay stencils by an administrator. The Form G was used for this study. The reliability and validity of the MBTI was discussed earlier in Chapter 1 (p. 13)

The author was the sole administrator of the survey. Certification of the author to administer the MBTI was granted by CAPT after attending a five day course which covered the theory behind the personality types, ethical uses in research of the MBTI and the construction and scoring of the MBTI. A passing score on a review exam was the criteria for receiving certification.

The MBTI was administered during a class period early in the semester. An explanation of the concepts behind the MBTI and the research

project was delivered during the first 10 minutes of the period. Each student was then allowed to complete the MBTI protocols during the remaining class time. At the end of the class the surveys were collected along with signed consent forms.

The complete statistical analysis was carried out by the author. Conversion of student scores to standard scores and the final ANOVA analyses were performed by the Stat View II™ (1987-1988, Abacus Products) computer program on an Apple Power Macintosh 6500.

Procedure

Permission to allow Middle Tennessee State University students and professors to participate in this study was obtained from the MTSU Institutional Review Board (see Appendix). Students were advised that their final grades would be reported to the author by their instructor. Notification that their participation in the study was voluntary and that their individual identities would remain anonymous was provided during the introduction at the start of each class period. Signed consent forms were collected as their acknowledgement to the foregoing conditions of the study.

All classes were surveyed during the two semesters of Fall 1996 and Spring 1997 with the exception of two Chemistry 112 sections which were surveyed in the 1997 Fall semester. All forms were computer scanned by the Center for Applications of Personality Types in Gainesville, Fl. with the

exception of the two Chemistry 112 classes which were hand scored by the author.

Special effort was made to survey the students before the first exam. Although no final grade was assigned to students who withdrew before the semester's withdrawal deadline, the author desired to keep a record of personality types for all the students who enrolled in each course.

Sixteen groups constitute the group of personality types. An ANOVA statistical study was used to determine the significance between the final scores of the sixteen personality types.

Internal Validity

The allotted time to complete the MBTI varied between classes. A class scheduled on Mondays, Wednesdays and Fridays (MWF) is 50 minutes long while one scheduled on Tuesdays and Thursdays (TTh) is 1 hour 15 minutes long. Therefore, students who completed the MBTI on MWF may have felt rushed and possibly could have finished the survey haphazardly. Though this possibility existed, several existing factors may negate this effect. First, the Form G is set up with a format to minimize this exact concern. Two types of questions are included in the survey; questions posed to ascertain individual type and research questions for future surveys. The proposed research questions are positioned at the end of the study and are not scored in determining type. Thus, a student rushing through the last few

questions would still provide valid data for type determination.

The second factor which would indicate that class length would have minimal influence on the study was the average time students needed to complete the MBTI. Although no data were collected to verify this claim, the author could not recall any students in a TTh class needing more than one hour to complete the MBTI. One or two students in a MWF class did need more than 50 minutes, which was provided by allowing the student to finish the survey outside the classroom.

The differences in instructors may be suspect as being very influential upon students' grades. The effects could range from the instructor's own personality type having a profound influence as transmitted via favored teaching styles to various methods instructors use for testing and evaluations. A total of 24 sections were included in the study; seven sections for the Physical Science 100 and Chemistry 112, and 10 sections for the 121/122 (2 of which were Chemistry 122). Thirteen professors (more than one-half of the available instructors) were assigned to the 24 sections with two professors handling 3 sections each of Physical Science 100 and Chemistry 121/122. These two professors did account for approximately 20% of the students in each course. No attempt was made to specifically qualify any relationship with the personality types of the instructors, but by coincidence the instructors responsible for the classes in this study covered all the different personality types available in the sample of the instructors

(Figure 5). However, this does not rule out positive or negative reinforcements in instruction due to instructors' personality type.

Final percent grades were used as the sole criteria for grading in this study. This eliminated any subjectivity introduced by converting a percent score into a letter grade. Each student's score was converted into a standard score to achieve one set of data for each course. A standard score of 70 with a standard deviation of 10 was used for each cousre.

A remaining issue concerning the grades used in this study was how to handle students who did not fulfill the class requirements by choosing not to complete the laboratories or failing to participate in the last examinations. These students would receive a final percent score which could drastically affect the statistical analysis. Since the percent grade was the primary consideration in this study, a 'cut off' percent was set to prohibit very low final grades from giving extraordinarily undue weight to each type's average. From an interpretation of the data it was evident that the students who did not participate in the last exam or final examination received scores below a certain percent. This percent point was 40 percent for the Chemistry 112 and 121/122 courses and 30 percent for the Physical Science 100 course. In almost all cases students who percentages were higher than the 'cut off' percent did receive a letter grade of A, B, C, or D. Only 2 exceptions were found to violate this assumption. In these cases the students received a D grade for a lower percentage. They were not included in the final statistics of those who passed.

N = 24

ISTJ N=7 %=29.2	**ISFJ** N=1 %=4.2	**INFJ** N= 1 %=4.2	**INTJ** N=4 %=16.7
ISTP N=1 %=4.2	**ISFP** N=0 %=0.0	**INFP** N=1 %=4.2	**INTP** N=1 %=4.2
ESTP N=0 %=0.0	**ESFP** N=0 %=0.0	**ENFP** N=0 %=0.0	**ENTP** N=0 %=0.0
ESTJ N=2 %=8.3	**ESFJ** N=0 %=0.0	**ENFJ** N=1 %=4.2	**ENTJ** N=5 %=20.8

Figure 5. Distribution of Personality Types for MTSU Chemistry Instructors Surveyed.

Sampling of the students for the three courses was not completely random. Although all the Chemistry course sections in each semester were designed into the study, the Physical Science 100 sections were based on the criteria of the instructor being employed through the Chemistry Department and on class size. Due to the fact that each course specifically addresses the needs of students from certain disciplines it is conceivable that the distribution of types may not be similar among the three courses. Comparisons between each course and the MTSU students surveyed were performed using a chi square analysis to identify significant variation in the distribution of personality types.

Statistical Analysis of Data

Each student's final percent grade was recorded at the end of the semester. To make data analysis more easily comprehendible, each student's score was then organized into one cohesive listing with an average of 70 and standard deviation of 10.

Each student's personality type and standard score were entered into the Stat View® statistical program. To determine the existence of any significant variability between the sixteen groups, a single factor, factorial ANOVA analysis was performed using this program. If the significance level for differences in scores among the whole group was less than 0.05 then pairings of personality types were evaluated at both the 0.05 and 0.01

confidence levels (based on the Fisher's Protected Least Significant Difference).

Comparisons of personality type distributions between each course and the complete population of students surveyed were made to further substantiate the claim of the study's internal validity. This was accomplished through the use of the Selection Ratio Type Table (SRTT). The SRTT is a computer program designed by Raymond Moody (University of Hawaii), Glenn Granade (Center for Applications of Psychological Type), and Isabel Briggs Myers (Center for Applications of Psychological Type) and it is copyrighted by the Center for Applications of Psychological Type, 1993. Using a given population the SRTT is designed to calculate percent distributions of the sixteen types. The SRTT can also be used to calculate a chi square statistical analysis between two samples, which may be dependent or independent. The program reports the significance of the ratio for each personality type between samples at the lowest significant level for $p < 0.05$, 0.01, and 0.001.

CHAPTER 3

RESULTS AND DISCUSSION

Discussion of Hypothesis

The hypothesis for this study was evaluated in light of the data obtained. These data are summarized in Tables 1-3.

Null Hypothesis:

There will be no significant differences in percent grades within a course based on personality type.

Table 4 contains the resulting confidence levels based on the statistical ANOVA for the three courses. Based on the identified p values the null hypothesis is rejected for Physical Science 100 ($p = 0.014$) and Chemistry 121/122 ($p = 0.048$) but is accepted for Chemistry 112 ($p = 0.08$).

A $p = 0.014$ for the Physical Science 100 course implies that some differences between student scores exist within the sixteen personality types. Further analysis determined differences between the INFP type score and the scores of the following types: ISTP, INTJ, ISFJ, ESTP, ESFP, ESFJ, ENFP, to be statistically significant at the 0.01 confidence level (Table 5). At a 0.05 confidence level INFPs had a higher score than ISTJs, INTPs, ESTJs, ENTPs .

Table 1

Summary of Data (with accompanying graph) for the 16 MBTI Types in Physical Science 100.

MBTI Type	No. Passed	Average	s.d.	No. dropped	% dropped
ISTJ	41	72.1	7.8	4	9
ISTP	16	66.0	8.9	1	6
ISFJ	30	70.8	9.6	0	0
ISFP	13	72.1	8.4	3	19
INTJ	14	69.9	9.2	0	0
INTP	10	70.2	9.1	1	9
INFJ	7	75.4	15	1	13
INFP	16	78.4	5.6	1	6
ESTJ	27	71.6	9.4	5	16
ESTP	21	66.7	6.8	3	13
ESFJ	36	69.7	8.9	1	3
ESFP	28	68.5	9.1	0	0
ENTJ	6	73.3	9.3	0	0
ENTP	10	70.3	5.7	2	17
ENFJ	6	71.8	6.5	0	0
ENFP	44	69.0	8.7	6	12
Totals	325	70.0	10	28	9

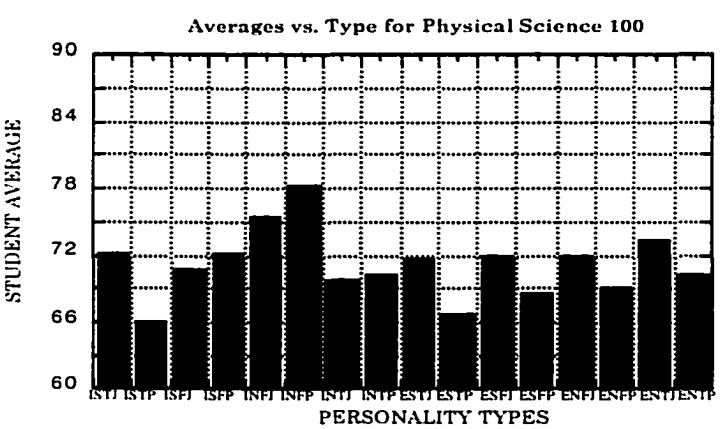

Table 2
Summary fo Data (with accompanying graph) for the 16 MBTI Types in Chemistry 112.

MBTI Type	No. Passed	Average	s.d.	No. dropped	% dropped
ISTJ	17	72.9	11.5	6	26
ISTP	4	54.6	12.3	1	20
ISFJ	32	71.0	9.1	2	6
ISFP	11	67.3	5.2	1	8
INTJ	8	77.2	7.6	1	11
INTP	4	71.3	7.6	2	33
INFJ	4	67.6	11.3	3	43
INFP	8	71.6	9.9	2	20
ESTJ	16	69.5	11.1	8	33
ESTP	11	65.7	14.4	4	27
ESFJ	24	73.0	7.6	6	20
ESFP	16	67.8	8.6	2	11
ENTJ	4	70.6	13.9	1	20
ENTP	14	69.3	9.5	2	12
ENFJ	8	68.9	9.7	1	11
ENFP	14	68.5	7.4	4	22
Totals	195	70.0	10	46	19

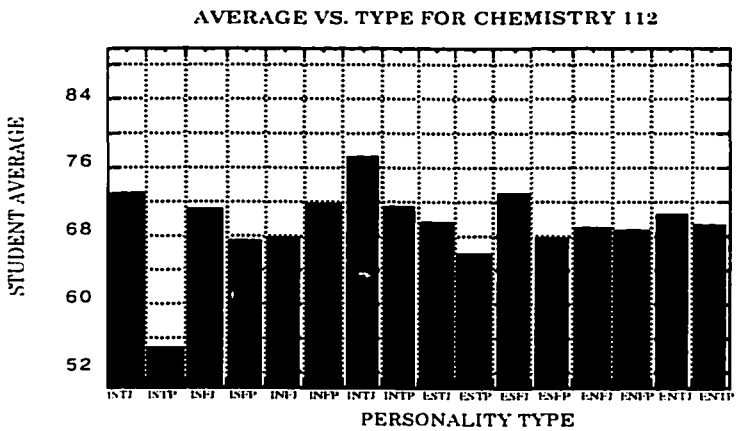

Table 3
Summary of Data (with accompanying graph) for the 16 MBTI Types in Chemistry 121/122.

MBTI Type	No. Passed	Average	s.d.	No. dropped	% dropped
ISTJ	38	70.7	9.59	11	22
ISTP	27	68.7	10.1	8	23
ISFJ	22	70.8	10.4	2	8
ISFP	13	69.5	9.78	3	19
INTJ	16	79.2	9.37	5	24
INTP	24	70.2	9.35	6	20
INFJ	5	68.3	12.4	1	17
INFP	22	71.9	8.71	6	21
ESTJ	35	68.8	9.74	8	19
ESTP	11	69.6	10.1	9	45
ESFJ	20	69.7	9.95	3	13
ESFP	27	65.4	9.39	4	13
ENTJ	10	73.3	10.5	4	26
ENTP	22	69.0	10.0	4	15
ENFJ	12	69.0	11.2	3	20
ENFP	17	67.2	10.0	9	35
Totals	321	70.0	10	86	21

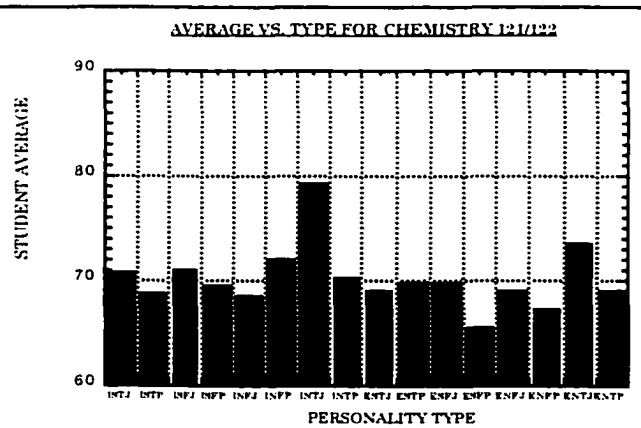

Table 4

Values for p from the ANOVA Analysis Between MBTI Type Pairings for Each Course.

Course	p value
Physical Science 100	0.014
Chemistry 112	0.080
Chemistry 121/122	0.048

Table 5

Statistically Significant Differences in Average Scores Between MBTI Types for Physical Science 100.

From F-test: p = 0.014

average of Type	with average of	significance *< 0.05, **< 0.01
INFP (78.4)	ISTJ (72.1)	*
	INTP (70.2)	*
	ESTJ (71.6)	*
	ENTP (70.3)	*
	ISTP (66.0)	**
	ISFJ (70.8)	**
	INTJ (69.9)	**
	ESTP (66.7)	**
	ESFP (68.5)	**
	ESFJ (69.7)	**
	ENFP (69.0)	**
ISTJ (72.1)	ISTP (66.0)	*
	ESTP (66.7)	*
INFJ (75.4)	ISTP (66.0)	*
	ESTP (66.7)	*
ESTJ (71.6)	ISTP (66.0)	*

Additionally ISTJs' and INFPs' scores were higher than ISTPs' and ESTPs' at the 0.05 confidence level. The ESTJs' average was significantly higher than ISTP's with 0.05 confidence.

The $p = 0.08$ for the comparison within the Chemistry 112 course was higher than the standard of 0.05 designated for this study. However, since this was the only course that did not meet the standard, further analysis for differences between groupings was performed for completeness.

For this class statistically significant differences exist between the ISTPs' average and the averages of the INTJs, ISFJs, ISTJs, ENTPs, ESTJs, and ESFJs at the 0.01 confidence level (Table 6). At a 0.05 confidence level, differences between the ISTPs' average and the averages of the ISFPs, INTPs, ESTPs, ENTJs, ENFPs, ENFJs, and ESFPs were found. The INTJs' average was higher than for ISFPs, ESTPs, ENFPs, and ESFPs, also, at a 0.05 confidence level.

A $p = 0.048$ means that differences between personality type averages found in the Chemistry 121/122 course are present with 0.05 confidence. Further investigation finds that at a 0.01 confidence level the INTJs had a higher average than the ISTPs, ISTJs, INTPs, ISFPs, ISFJs, ESFPs, ENFPs, ENTPs, ESTJs, ESFJs and ENFJs (Table 7). At a 0.05 confidence level the INTJs also scored higher than INFPs, INFJs, and ESTPs. The ENTJs' average is the only one not significantly lower.

Table 6

Statistically Significant Differences in Average Scores Between MBTI Types for Chemistry 112.

From F-test: p = 0.08

average of Type	with average of	significance *< 0.05, **< 0.01
ISTP (54.6)	ISFP (67.3)	*
	ESTP (65.7)	*
	INTP (71.3)	*
	ENTJ (70.6)	*
	ENFP (68.5)	*
	ENFJ (68.9)	*
	ESFP (67.8)	*
	ISFJ (71.0)	**
	ISTJ (72.9)	**
	INTJ (77.2)	**
	ENTP (69.3)	**
	ESTJ (69.5)	**
	ESFJ (73.0)	**
INTJ (77.2)	ISFP (67.3)	*
	ESTP (65.7)	*
	ENFP (68.5)	*
	ESFP (67.8)	*

Table 7

Statistically Significant Differences in Average Scores Between MBTI Types for Chemistry 121/122.

From F-test: p = 0.048

average of Type	with average of	significance *< 0.05, ** <0.01
INTJ (79.2)	ESTP (69.6)	*
	INFP (71.9)	*
	INFJ (68.3)	*
	ISTP (68.7)	**
	ISTJ (70.7)	**
	INTP (70.2)	**
	ISFP (69.5)	**
	ISFJ (70.8)	**
	ESFP (65.4)	**
	ENFP (67.2)	**
	ENTP (69.0)	**
	ESTJ (68.8)	**
	ESFJ (69.7)	**
	ENFJ (69.0)	**
ISTJ (70.7)	ESFP (65.4)	*
INFP (71.9)	ESFP	*
ENTJ (73.3)	ESFP	*

The data revealed that 3 other types scored significantly higher than the ESFP type with 0.05 confidence: ISTJs, INFPs and ENTJs.

Discussion of Internal Validity

Examination of the data obtained in this study beyond what was required to substantiate or refute the hypothesis revealed additional information related to internal validity. First some mention must be given to the distribution of the sixteen types within the 1085 students surveyed and within each course. As previously stated, this task was accomplished through the use of the SRTT.

A comparison between the sample of the 1085 MTSU students surveyed and the distribution of personality types commonly found among the general population is shown in Figure 6. (Note: In order to make this comparison one assumption must be used. The percentages of types given by Lawrence for the general population (see p. 12) must be converted into a real sample size in order to perform the chi square analysis. The **Manual: A Guide to the Development and Use of the Myers-Briggs Type Indicator** (*3*, p. 3) states that the number of data entries in the MBTI database is well over 250,000. Unfortunately, the SRTT only accepts samples with a number less than 50,000. The assumption to use the number of 10,000 as the sample size was invoked for two reasons: it allowed for simple conversions from the percentages and the results were very similar to results obtained with greater

numbers.) Comparisons between the MTSU sample and each course are exhibited in Figures 7-9.

The SRTT reported (Figure 6) that the MTSU sample used for this study had several significant variations among the sixteen types. Types which were under represented were INFJ, ENFJ and ENTJ with respective ratios of 0.47, 0.53, and 0.45 to the general population. This indicates that each of the three types in the MTSU sample were approximately one half the percentage expected. The ratios for types INFP, INTP and ENFP were found to be 2.08, 1.92 and 2.39, respectively, indicating that the surveyed sample had almost double the number of these types. The significance level for each preceding ratios stated was 0.001. At a significance level of 0.01, our survey contained higher quantities of the ISTJ and ENTP types (1.31 and 1.49 respectively) and a lower number of ESFJ (0.75) (Figure 6).

In summarizing the differences in the distribution of the personality types in this study, it is notable that approximately twice the levels of the four NP types and nearly one half of the levels of the four NJ types are present. The MBTI Manual (*3*, p. 36) describes NP types as unconventional, independent spirits with disdain for being fenced in while the NJ types strive for inner understanding with drive, persistence, and determination. This author can only speculate that a reason for this difference may be found in the relationship between a public state-funded and a private university. The NJ type could certainly describe the historically typical college student.

N = 1085

ISTJ N= 122 %= 11.2 I = 1.31*	**ISFJ** N= 106 %= 9.8 I = 1.14	**INFJ** N= 22 %= 2.0 I = 0.47**	**INTJ** N= 49 %= 4.5 I = 1.05
ISTP N= 64 %= 5.9 I = 1.02	**ISFP** N= 45 %= 4.1 I = 0.72	**INFP** N= 63 %= 5.8 I = 2.08**	**INTP** N= 58 %= 5.3 I = 1.92**
ESTP N= 62 %= 5.7 I = 0.74	**ESFP** N= 80 %= 7.4 I = 0.95	**ENFP** N= 98 %= 9.0 I = 2.39**	**ENTP** N= 61 %= 5.6 I = 1.49*
ESTJ N= 103 %= 9.5 I = 0.83	**ESFJ** N= 93 %= 8.6 I = 0.75*	**ENFJ** N= 32 %= 2.9 I = 0.53**	**ENTJ** N= 27 %= 2.5 I = 0.45**

* significant @ < 0.01
* * significant @ < 0.001

Figure 6. SRTT for Middle Tennessee State University Students Surveyed Compared to General Population.

N = 353

ISTJ N=45 %=12.8 I= 1.13	**ISFJ** N=30 %=8.5 I= 0.87	**INFJ** N= 8 %=2.3 I= 1.12	**INTJ** N=14 %=4.0 I=0.88
ISTP N=17 %=4.8 I=0.82	**ISFP** N=16 %=4.5 I= 1.09	**INFP** N=17 %=4.8 I= 0.83	**INTP** N=11 %=3.1 I= 0.58
ESTP N=24 %=6.8 I=1.19	**ESFP** N=28 %=7.9 I= 1.08	**ENFP** N=50 %=14.2 I= 1.57**	**ENTP** N=12 %=3.4 I = 0.60
ESTJ N=32 %=9.1 I= 0.95	**ESFJ** N=37 %=10.5 I= 1.22	**ENFJ** N=6 %=1.7 I= 0.58	**ENTJ** N=6 %=1.7 I= 0.68

* significant @ < 0.01
** significant @ < 0.001

Figure 7. SRTT for Physical Science 100 Students Compared to MTSU Students Surveyed.

N = 241

ISTJ N=23 %=9.5 I= 0.85	**ISFJ** N=34 %=14.1 I= 1.44*	**INFJ** N= 7 %=2.9 I= 1.43	**INTJ** N=9 %=3.7 I=0.83
ISTP N=5 %=2.1 I= 0.35*	**ISFP** N=12 %=5.0 I= 1.2	**INFP** N=10 %=4.2 I= 0.71	**INTP** N=6 %=2.5 I= 0.47
ESTP N=15 %=6.2 I= 1.09	**ESFP** N=18 %=7.5 I= 1.01	**ENFP** N=18 %=7.5 I= 0.83	**ENTP** N=16 %=6.6 I= 1.18
ESTJ N=24 %=10.0 I= 1.05	**ESFJ** N=30 %=12.5 I= 1.45	**ENFJ** N=9 %=3.7 I= 1..27	**ENTJ** N=5 %=2.1 I= 0.83

* significant @ < 0.01

Figure 8. SRTT for Chemistry 112 Students Compared to MTSU Students Surveyed.

N = 407

ISTJ N=49 %=12.0 I= 1.07	**ISFJ** N=24 %=5.9 I= 0.60**	**INFJ** N= 6 %=1.5 I= 0.73	**INTJ** N=21 %=5.2 I= 1.14
ISTP N=35 %=8.6 I= 1.46*	**ISFP** N=16 %=3.9 I= 0.95	**INFP** N=28 %=6.9 I= 1.18	**INTP** N=30 %=7.4 I=1.38
ESTP N=20 %=4.9 I= 0.86	**ESFP** N=31 %=7.6 I= 1.03	**ENFP** N=26 %=6.4 I= 0.71	**ENTP** N=26 %=6.4 I= 1.14
ESTJ N=43 %=10.6 I= 1.11	**ESFJ** N=23 %=5.7 I= 0.66*	**ENFJ** N=15 %=3.7 I= 1.25	**ENTJ** N=14 %=3.4 I= 1.38

* significant @ < 0.01
** significant @ < 0.001

Figure 9. SRTT for Chemistry 121/122 Students Compared to MTSU Students Surveyed.

However, as the general population recognizes the economic power of a post-high school education, many more may decide to enter college. It may be likely that a student whose sole motivation to pursue a form of higher education is for economic gain may choose a state funded public institution because of reasonable costs and entrance requirements. Thus the unconventional and independent NP population may be higher at an institution like MTSU.

Both expected and unexplainable differences in the distribution of personality types are noticed among the three courses. The ratio of 1.57 ($p < 0.001$) for the ENFP type was the only statistically significant variation found in the Physical Science 100 class (Figure 6). A possible explanation could be found in the type of student who enrolls in the class. As previously mentioned, Physical Science 100 is one choice for a science requirement for every student, with exception for science or health science students who would enroll in either the Chemistry 111/112 or Chemistry 121/122 sequences. Typical disciplines of study for the Physical Science 100 student would be mass communication, performing arts, business, etc. Interestingly, the top 5 professions (MBTI Manual) with large percentages of ENFP types are journalists, counselors, psychologists, teachers (art, drama and music) and writers, artists and entertainers.

Examination of the Chemistry 112 course and Chemistry 121/122 revealed a shift in type distribution. The Chemistry 112 course contains higher percentages of ISFJ and ESFJ (1.44 and 1.45, respectively, both $p <$

0.01)(Figure 7) while a decrease in percentages was seen in the Chemistry 121/122 course: ISFJ:0.60 ($p<0.001$) and ESFJ: 0.66 ($p<0.01$) (Figure 8). A lower percentage (0.35 vs. 1.46 ratios, $p<0.01$) of the ISTP type was identified in the Chemistry 112 course (Figure 7) compared to the Chemistry 121/122 course (Figure 8).

Although the later difference can not be explained it is of interest to note that the CAPT MBTI Manual lists the occupation with the highest percentage of ISTPs as farmers. Since the Chemistry 112 course is a required course for the Animal Science majors, the opposite numbers would be expected.

The differences between the percentages of ISFJ (14.1%) and ESFJ (12.5%) types in the Chemistry 112 and the low percentages of the two types (5.9% and 5.7% respectively) in the Chemistry 121/122 can be explained quite easily. The CAPT's database (25) listings show that a large percentage of ISFJ (22%) and ESFJ (15%) types state nursing as their occupation. As the Chemistry 111/112 sequence is the required chemistry sequence for the nursing program it is expected that percentages of these two types would be shifted from the Chemistry 121/122 to the Chemistry 111/112 sequence.

Discussion of Hypothesis I

The significance of this study is found in the results concerning the differences in grade averages between types in each course. The ANOVA

analysis indicated that two of the courses (Physical Science 100 and Chemistry 121/122) had significant variation between scores. The Chemistry 112 significance between groups of $p < 0.08$ was not at the accepted level of $p < 0.05$ for this study, however, the author feels that explaining between group variations even at this level is useful because such an analysis provides some interesting parallels between the two Chemistry courses (Perhaps further studies of a larger sample size may produce the desired significance.)

In the Physical Science 100 course the high averages by the INFPs and the INFJs were unexpected. An explanation for this result may be found in the curriculum and the laboratory approach to the course The curriculum in Physical Science 100 spans several fields; from chemistry and physics to earth science and astronomy. The laboratory procedures are designed to elicit the inquisitive nature of the student and emphasizes the scientific method. The author's experience in a general chemistry laboratory is quite the opposite as many labs seemed to be designed in a cookbook fashion leading to the student's sole objective of getting 'the correct answer' which will reward the student with a high grade. The slightly different pedagogy of the Physical Science 100 course may provide some clues on how to broaden a chemistry class's appeal to a variety of students.

The Chemistry 112 course produced quite different results from the Physical Science 100 course. The ISTP type was found as the lowest achiever with the majority of the types scoring significantly higher averages. At the

top of the class was the INTJ type (average = 77.2) which was significantly higher than the ISFPs, ESTPs, ENFPs, and the ESFPs.

As different as the Chemistry 112 course results were from the Physical Science 100 course, they were strikingly similar to the Chemistry 121/122's. The parallel result of the INTJs as the top performers with a 79.2 percent average is very intriguing, and it may indicate that, although the content in the two courses are designed for different audiences, a similarity may still be present in the way the courses are structure and presented.

Every type (except the ENTJs) were outscored by the INTJs, but note must be taken of the two types at the bottom of the class averages: the ESFPs and ENFPs. When evaluating the performance of these two types, some additional consideration should also be given to the level of withdrawals, incompletes and failures of each type (Table 3). The ENFPs and the ESTPs had very high percentages of 33% and 45%, respectively, compared to the average rate of 21%. This factor, although mathematically impossible to incorporate into the final type average, is very significant. Certainly the combination of a low average and high failure rate of the ENFP personality implicates this type as the one (along with ESFPs and ESTPs) which lowers the bell curve while the INTJs appear to be the curve breakers.

With consideration of assignment of a final grade to student performance, two common systems are used; performance based, where knowing 90 percent of the material might earn an A grade, and percentile

base, where the top 10% of the class earn an A. If a chemistry instructor chooses the latter then the results of this study may be clearer when viewed in a slightly different manner. Tables 8-13 show the rankings of the types when considering only the top percentages for each course (10% was used for the Physical Science 100 and Chemistry 121/122 courses, while 15% was chosen for the Chemistry 112 due to the smaller sample size). It is evident that 3 of the top 4 groups (INTJ, ISTJ and ESTJ for both chemistry courses) and 2 of the 4 (ISTJ and ESTJ for Physical Science 100) are also the same types for 80% of the MTSU instructors (ISTJ, INTJ, ESTJ and ENTJ) (Figure 5). Figures 11-13 show the dominance of the INTJ as identified by the high percentage of the type dominating the top percentages.

Although this study included no specific variables to scrutinize any possible connections between the personality types of instructors and their students the similarities between the large percentage of TJ instructors and the prominence of the TJ types in the top percentages are astonishing. The literature review makes a case that students have a better chance for success in any endeavor in which they find the material, the work, and the structure parallel to their individual styles. As successful chemistry graduates continue on in their discipline by becoming professors, their learning styles maybe used as a basis for their teaching styles. Thus, a discipline is cultivated with certain styles and characteristics that have been deemed acceptable to the field. The students who react favorably with these same

styles and characteristics will do so because their personality types provide an advantage by making the work enjoyable and interesting.

Table 8
Ranking of the 16 MBTI Types by Number in the Top 10% of Scores for Physical Science 100.

N = 325

MBTI Type	Total no.	Percentage
ISTJ	6	18.2
INFP	5	15.2
ESTJ	4	12.1
ESFJ	4	12.1
ENFP	4	12.1
ISFJ	2	6.1
INFJ	2	6.1
ENTJ	2	6.1
ISFP	1	3.0
INTJ	1	3.0
INTP	1	3.0
ESFP	1	3.0
ESTP	0	0
ENTP	0	0
ENFJ	0	0
ISTP	0	0
	33	

Table 9

Ranking of the 16 MBTI Types by Number in the Top 15% of Scores for Chemistry 112.

N = 195

MBTI Type	Total no.	Percentage
ISTJ	6	20.0
ISFJ	5	16.7
ESFJ	4	13.3
INTJ	3	10.0
ESTJ	3	10.0
ENTP	2	6.7
ESTP	2	6.7
INFP	1	3.3
ESFP	1	3.3
ENFJ	1	3.3
ENTJ	1	3.3
ENFP	1	3.3
ISTP	0	0
INFJ	0	0
ISFP	0	0
INTP	0	0
	30	

Table 10

Ranking of the 16 MBTI Types by Number in the Top 10% for Chemistry 121/122.

N = 321

MBTI Type	Total no.	Percentage
INTJ	6	18.8
ISTJ	4	12.5
ESTJ	4	12.5
ISFJ	3	9.4
ENTP	3	9.4
ENTJ	2	6.2
ENFP	2	6.2
INTP	2	6.2
ESFJ	1	3.1
ISTP	1	3.1
ENFJ	1	3.1
INFP	1	3.1
ESTP	1	3.1
INFJ	1	3.1
ISFP	0	0
ESFP	0	0
	32	

Table 11

Ranking of the 16 Types Scoring in the Top 10% of Physical Science 100. by Percentage of the Total Passed.

N = 325

MBTI Type	Number	Total of Type Passing	Percentage
ENTJ	2	6	33.3
INFP	5	16	31.3
INFJ	2	7	28.6
ESTJ	4	27	14.8
ISTJ	6	41	14.6
ESFJ	4	36	11.1
INTP	1	10	10.0
ENFP	4	44	9.1
ISFP	1	13	7.7
INTJ	1	14	7.1
ISFJ	2	30	6.7
ESFP	1	28	3.6
ESTP	0	21	
ENTP	0	10	
ENFJ	0	6	
ISTP	0	16	
	33		

Table 12

Ranking of the 16 Types Scoring in the Top 15% of Chemistry 112 by Percentage of the Total Passed.

N = 195

MBTI Type	Total no.	Total of Type Passing	Percentage
INTJ	3	8	37.5
ISTJ	6	17	35.3
ENTJ	1	4	25.0
ESTJ	3	16	18.8
ESTP	2	11	18.2
ESFJ	4	24	16.7
ISFJ	5	32	15.6
ENTP	2	14	14.3
INFP	1	8	12.5
ENFJ	1	8	12.5
ENFP	1	14	7.2
ESFP	1	16	6.3
ISTP	0	4	0
INFJ	0	4	0
ISFP	0	11	0
INTP	0	4	0
	30		

Table 13

Ranking of the 16 Types Scoring in the Top 10% of Chemistry 121/122 by Percentage of the Total Passed.

N = 321

MBTI Type	Total no.	Total of Type Passing	Percentage
INTJ	6	16	37.5
ENTJ	2	10	20.0
INFJ	1	5	20.0
ISFJ	3	22	13.6
ENTP	3	22	13.6
ENFP	2	17	11.8
ESTJ	4	35	11.4
ISTJ	4	38	10.5
ESTP	1	11	9.1
INTP	2	24	8.3
ENFJ	1	12	8.3
ESFJ	1	20	5.0
INFP	1	22	4.5
ISTP	1	27	3.7
ISFP	0	13	0
ESFP	0	27	0
	32		

REFERENCES

1. Felder, Richard M.; *Engineering Education*. April **1988**, 674-681.

2. Tobias, Sheila; *They're Not Dumb, They're Different: Stalking the Second Tier*; Research Corp., Tucson, AZ, 1990.

3. Briggs Myers, Isabel; McCaulley, Mary; *Manual: A Guide to the Development and Use of the Myers-Briggs Type Indicator*; Consulting Psychologists: Palo Alto, CA, 1985.

4. Dunn, R.; Beaudry, J.; Klavis, A. *Education Leadership*. March **1989**, 50-58.

5. Thorndike, Edward L. *Individuality*; Boston: Houghton Mifflin, 1911; 51.

6. Jung, C.G.; *Complete Works, Volume 6: Psychological Types*; Bollingen: Princeton, NJ, 1971.

7. Schuells, Thomas J.; Farley, Frank H. and Neal J. Gordon, editors, *Psychology and Education: The State of the Union*. Berkeley: McCutchan Publishing, 1981; 32-59.

8. Barger, Robert R.; Hoover, Randy L. *Theory Into Practice*. **1984**, *23(1)*, 56-63.

9. Meisgeier, C.; Murphy, E. A.; *The Murphy-Meisgeier Type Indicator for Children: Manual*; Palo Alto, CA: Consulting Psychologists Press, 1987.

10. Fourqurean, John M.; Meisgeier, C.; Swank, P.; *J. of Experimental Education*, **1989**, *58(3)*, 225-237.

11. Jung, C. G. *Complete Works, Volume 7: Two Essays on Analytical Psychology*; Bollingen: Princeton, NJ, 1971; par. 79.

12. Bronowski, Jacob. *Science and Society: Selected Essays*. Vavoulis, A. and A. Wayne Colver, Eds. San Francisco: Holden-Day; 1966; 75-88.

13. Woodhull, John. *The Teaching of Science*; New York:MacMillan, 1918; 4.

14. Capra, Fritjof. *The Tao of Physics*; Boston: Shambala, 1991; 167.

15. Jouvenel, Betrand de. *Science and Society: Selected Essays.* Vavoulis, A. and A. Wayne Colver, Eds. San Francisco: Holden-Day, 1966; 75-88.

16. McCaulley, Mary H; *J. College Sci. Teaching,* **1977**, *7(2)*, 114-120.

17. Lawrence, G. *People Types and Tiger Stripes*; Gainesville, FL:CAPT. 1995.

18. Stricker, L. J. et al.; *Educational and Psychological Measurement*, **1965**, 25(4), 1081-1095.

19. Melear, C. T. Cognitive Processes in the Curry Learning Style Framework as by the Learning Style Profile and the Myers-Briggs Type Indicator Among Non-majors in Biology. *Dissertation Abstracts International* 1990, 51-1:127-A.

20. Tharp, G. D.; *American Journal of Physiology,* **1992**, *62*, 51-53.

21. Tharp, G. D. *J. College Sci. Teaching* , **1993**, *22(5)*, 276-278.

22. MacKinnon, Donald A.; *American Psychologist,* **1962**, *17*, 484-495.

23. Charles, C. M. *Introduction to Educational Research*, New York: Addison Wesley Longman; 1998.

Appendix

Consent and Release Forms

Dear Student,

I am currently working towards my doctorate in Chemical Education. I am researching learning and teaching styles and how they relate to chemistry classes. To complete my study I need to be able to categorize student's learning preferences. This can be done using a Myers-Briggs Type Indicator, which is a well researched and accepted research questionnaire. This indicator will ask you to identify your preference given an either/or scenario. I will correlate grades with each student's personality type. Your preferences will help me in understanding how students relate to material which may lead to new methods of presenting chemical instruction. This indicator **does not** provide me with any other information.

I will be asking students in the general chemistry and physical science classes to fill out the questionnaire. It consists of 126 questions and should take about 45 minutes. This questionnaire is not related to your participation in class and your professor will receive no information about how you answered the indicator. Each student's form will be consolidated into the class and no individual will be singled out. Your participation is voluntary and your grade for the class is not affected by your decision. If you do choose to participate and later change your mind, I will withdraw your data from the study.

I do hope that each of you will choose to participate. This form has been used extensively in other areas; helping people to evaluate a chosen career path and assisting people with personal relationships. I have arranged it with the counseling center if you have any interest in using this information for your own personal interests (please contact Dr. Jane Tipps to set up an appointment) or you may contact me directly for further information.

I can be contacted at 890-5006 or through the chemistry office if you would like to talk with me about this questionnaire. I would like to thank you for your participation ahead of time.

Please sign the following form if you agree to participate.

Thank you,

Wayne Riley

Consent Form

By signing this form, I understand that my grades and personality type will be used as research material. I maintain that I am doing this of my own free will. I also understand that my grade in this class will in no way be affected by my participation in this research.

Confidentiality of my grades and name will be assured and I also reserve the right to withdraw at anytime.

Signature _____

Printed Name _____

Date _____

MEMO

TO: Wayne D. Riley

FROM: JAMES V. BALCH
Basic and Applied Sciences Representative
Institutional Review Board

RE: Research Application
IRB Protocol No. 97003
Submitted for expedited review

DATE: July 26, 1996

This is to officially notify you that your research proposal,

MBTI Evaluation of Students and Professors in Chemistry
111, 112, 121, and 122

qualifies, in my opinion, for expedited review and is herewith approved by me as the representative from your college of the Institutional Review Board. Good luck as you pursue this project.

James V. Balch

/mh

C A P T
The Vision. The System. The Original.

Center for Applications of Psychological Type
2815 N.W. 13th Street, Suite 401
Gainesville, Florida 32609
E-mail capt@capt.org

Tel (352) 375-0160
Fax (352) 378-0523

May 29, 1998

Wayne D. Riley
2503 Woods Court
Murfreesboro, TN 37130

Dear Mr. Riley, You are hereby granted permission to reproduce and/or adapt the following material published by the Center for Applications of Psychological Type:

> Brief Descriptions of the Sixteen Types, page 14, *People Types and Tiger Stripes*, 3rd edition, by Gordon D. Lawrence, 1993.
>
> Understanding the Type Table, by Mary H. McCaulley. Copyright 1976 Center for Applications of Psychological Type.

This is one-time permission for these items to be used in your doctoral dissertation, tentatively titled "Using Jung's Personality Typology as Identified by the Myers-Briggs Type Indicator to Distinguish Successful and Unsuccessful Students in Lower Level General Science Classes," for a Doctor of Arts degree at Middle Tennessee State University.

Permission is granted on the condition that the reproduced material:

(a) will be used only for the purpose stated above
(b) will cite the author and publisher of each item fully and correctly

Permission is also extended to University Microfilms International, Ann Arbor, Michigan, for the purposes of reproducing and distributing copies of the work.

Please sign and return one copy of this letter to confirm acceptance of these terms of agreement.

When it is completed we would very much appreciate a copy of your dissertation for the CAPT Isabel Briggs Myers Memorial Library. Donations to CAPT are tax-deductible and we would send you a letter of acknowledgement for your tax purposes.

If we can be of any further assistance with your MBTI endeavors, please let us know. We will be happy to help you in any way we can.

Sincerely yours,

Jamelyn R. Johnson
Copyrights & Permissions Manager

Enclosures:
Reply envelope
Extra copy of this letter

Wayne D. Riley
Wayne D. Riley

July 1, 1998
Date

VITAE

The author was born on January 26, 1961 in White Plains, New York. He graduated from Valley Central High School in 1979 and four years later in April of 1983 he graduated with a B. S. in Chemistry from the University of Dayton, Dayton, OH. Three more years later he received a M. A. in Chemistry from the University of Texas at Austin under the guidance of Dr. Allen J. Bard. He was then hired by Exxon Chemical Co. as a chemist carrying out basic research in such areas of emulsion polymerization and additive technology for polyethylenes and polypropylenes. He stayed with Exxon Chemicals for six years and then moved on to a Dutch international company called Akzo Nobel. For four years with this company he served in the capacity as a Technical Service Manager in the area of free radical initiators for the polyethylene, polystyrene and rubber sectors. He returned to graduate school at MTSU in 1995 to concentrate on obtaining a doctorate in the field of Chemical Education.