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Students' Attitudes Towards Statistics in Medical Research: A Comparison of Four Health Sciences Programs

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STUDENTS' ATTITUDES TOWARD STATISTICS IN MEDICAL RESEARCH: A COMPARISON OF FOUR HEALTH SCIENCES PROGRAMS

BY

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B.S., Physical Therapy, University of New Mexico, 1982

THESIS

Submitted in Partial Fulfillment of the
Requirements for the Degree of

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ABSTRACT OF THESIS

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Driven by a market that is imposing greater scrutiny on health care providers as well as by an explosive increase in health-related research, there is a growing need for an improved understanding of statistical design and analysis among today's students and practitioners in the health sciences. Although most students in the health sciences are required to take an introductory statistics course prior to entering their professional programs, little is known about the attitudes those students possess regarding the use of statistics in medical research.

The Survey of Attitudes Toward Statistics in Medical Research (ATSMR) which was used in this study was a modified version of the Survey of Attitudes Toward Statistics© (Schau, et al. 1995). It was developed to measure four dimensions of attitude toward statistics: Affect (positive and negative feelings concerning statistics), Cognitive Competence (attitudes about intellectual knowledge and skills applied to statistics), Value (attitudes about the usefulness, relevance and worth of statistics in personal and professional life) and Difficulty (attitudes about the difficulty of statistics as a subject).

The ATSMR was administered to 272 students in four health science programs at the University of New Mexico (UNM). Among the respondents

were 124 medical, 45 nursing, 55 physical therapy (PT) and 48 occupational therapy (OT) students, 139 of whom were in their first year and 133 in their second. Attitude profiles for first and second year students in each program were examined by performing four separate split-plot ANOVAs using attitude as the within-subjects variable and academic year as the between-subjects variable. On average, students in all four programs expressed significantly more positive attitudes regarding the value of statistics compared to the other three dimensions tested. With the exception of the first year OT students, all groups also showed significantly more positive attitudes toward their cognitive competence than their feelings toward statistics (Affect) or the difficulty of statistics as a subject. No significant differences were found on the Affect and Difficulty subscales for any of the student groups surveyed.

A final split-plot ANOVA was performed investigating the relationships between gender, previous statistics experience, academic year and attitude toward statistics using the medical student data only. No attitude differences were found based on previous experience with statistics; however, attitude was related to gender on two of the subscales. On average, males expressed significantly more positive attitudes toward their cognitive competence as well as their feelings toward statistics (Affect) than did females. Furthermore, the first year students responded more positively on all four attitude dimensions than the second year students.

Attitudes toward statistics were very consistent among students in the four UNM health science programs examined. An improved understanding of the attitude profiles exhibited by students in these programs may allow

educators to improve their methods of instruction and students to develop greater respect for the role of statistics in medical research.

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CHAPTER I - INTRODUCTION

Few issues in America today incite greater concern than the changing health care system. Medical practitioners and patients, alike, find themselves faced with profound uncertainties about the future. While managed care organizations place greater restrictions on access to previously routine services, the providers have been forced into the unfamiliar position of having to negotiate their roles and justify their very existence. Many professionals in the health care industry find it necessary to relinquish some of their responsibilities to lesser-trained, lower-paid individuals such as assistants and technicians. Furthermore, health providers are now being subjected to greater scrutiny on the part of both the consumers and the third-party payers. In short, the health industry in America today is scrambling for a new identity.

The Need for Quality Research in the Health Professions

An enduring axiom that accurately describes the human experience refers to the fact that the more we learn, the more our deficiencies are revealed. With every answer we find, new questions arise. Therefore, for all that medical research has discovered, those who are involved in seeking answers are constantly reminded of how much more there is to know. The universe of knowledge is infinite and enlightenment is a transient phenomenon.

Research is required to develop and evaluate theory, which then provides a firm base for the techniques and procedures used by the health care professional. Without objective evidence regarding the efficacy and the efficiency of treatment, clinical practice can be based on nothing more than faith, intuition

or vested interest. The call is therefore being raised from all disciplines within our medical system for an acceleration of research endeavors. Payton (1988) stated that all clinicians must be prepared to defend the value and effectiveness of their clinical interventions with rational and scientific evidence. In a similar voice, Lieske (1986) claimed that it is imperative that nursing validate the aspects of health care that are predominantly and appropriately the concern of nurses. These and similar proclamations have been made in virtually every medical trade journal in recent years.

The benefits to society that result from medical research are obvious. The inevitable result of quality research is an enhanced understanding of human function and disease as well as improved patient care and preventive practice. However, all too often clinicians are willing to accept well-established treatment protocols without appreciating the methodology which was used to substantiate them. Indeed, much of the theory upon which rehabilitative medicine is rooted is based on flawed studies that beg for validation (Bork, 1993). It is incumbent upon all who practice medicine to fulfill their responsibility to society by questioning the rationale for their own actions and by remaining current in their level of knowledge through scientific investigation and regular literature consultation.

In addition to the benefits that medical research offers to society, medical professions, themselves, can gain recognition and credibility by conducting and publishing research. For the most part, neither the public nor other health care professionals (including physicians) have an adequate understanding of physical therapy or the education one must receive in order to become a physical therapist (P.T.). The same can be said for other health professions including

occupational therapy (O.T.) as well as numerous nursing and medical sub-specialties. Each of these professions has its own priorities and its own unique way of evaluating and addressing patients' problems. Yet, when sharing research results and ideas, all of these professionals can speak the same language. For example, only through research and a common vocabulary can a P.T. who specializes in the treatment of the spine interact in a meaningful way with a chiropractor or an orthopaedic surgeon. Each of these professionals approaches back pain in a different way, yet each can benefit from the other's research. Sharing of research findings, rather than a meaningless bantering of anecdotal observations, is the dialogue in which professionals must engage in order to establish credibility and respect for one another.

In today's health care market environment all medical professionals need to be concerned about their own survival and growth. Research provides an affirmation of a profession's value to society and secures a role for that discipline in the future. Indeed, the growth of a profession tends to be proportional to the rate at which its body of knowledge grows, and this is the direct result of its commitment to research (Worthingham, 1960).

In the U.S. over the last four decades, health care costs have risen at a faster rate than both the Gross National Product and inflation (Bork, 1993). Because little has been done to arrest the momentum of this runaway phenomenon, increasing concern about a potential crisis is evident. Health care practitioners are being required to justify their roles in a patient's management in order to receive compensation from third-party payers. Consumers are demanding accountability and deserve to know what they are receiving for their

health care dollars. If any health profession is unable to justify its existence in terms of the benefits it can provide for patients, it will simply cease to receive remuneration and eventually cease to exist (Bork, 1993). Conversely, those professions which are able to substantiate their contributions toward health and well-being will continue to thrive and prosper. The very survival of many health professions may be in the balance and only through good clinical research can these professions assure themselves a future in the health care market.

Finally, involvement in research is a personally satisfying endeavor whether as an investigator or as a consumer. Not all medical practitioners must aspire to become clinical researchers. However, at a minimum, it is imperative that every clinician develop the necessary skills for recognizing when new information is needed and then possess the strategies required to find, understand, and apply that information. Critical review of the literature is an absolute requirement for competent clinical practice. An appreciation for sound research methodology is considered a basic skill for all health care professionals. Thus, it is incumbent on all medical programs to prepare their students to become life-long consumers of research literature and to develop a culture that continues to reward those who are committed to conducting research.

The Role of Statistics in Quality Health Sciences Research

According to Bork (1993), conclusions about various treatments and their effects must be based on an unbiased analysis of data; it is the only way to truthfully verify that observable changes are due to a particular intervention. This belief supports the need for statistics in health sciences research. All too

often, the clinical preferences and philosophies to which students are exposed are merely the product of personal experience on the part of the instructor. By refusing to substantiate their claims with solid statistical evidence, educators run the risk of diminishing the role of statistics in medical research. Attention to statistical methods and results helps individuals to be more critical in their interpretation of new information.

The use of statistics in medical research is not without its critics, however (Armitage & Berry, 1994). There are those within the health professions who believe that the explicit use of statistics in health-related studies contributes little to the progress of medicine. This may be because health providers are concerned at any one time with the treatment of individuals who differ from one another in significant ways. However, it is precisely this variability among individuals that justifies the use of statistical analysis in medical research. Through the use of statistical analysis, health professionals can systematically gain a better understanding of these variables in ways which clinical observation, alone, cannot.

Medical research is gradually becoming more statistical in character (Armitage & Berry, 1994). Yet, while researchers need to meet elevating expectations of up-to-date statistical analysis, they frequently must do so with no more than occasional consultation with specialist statisticians. This places a burden on the researcher and may discourage some individuals from getting involved in research. Without an emphasis on current statistical procedures and research methodology in our educational system, we may be facing a serious

risk of losing an entire generation of qualified researchers (Armitage & Berry, 1994).

Attitudes Toward Statistics

Statistical analysis has penetrated the research practices of an increasing number of professions, both medical and non-medical. This has led to an increase in the number of educational programs which are now requiring their students to complete at least a basic course in statistics (Schau, Stevens, Dauphinee & Del Vecchio, 1995; Zeidner, 1991; Garfield & Ahlgren, 1988). These courses are most often offered through the departments of mathematics, statistics, psychology, or education. For many of these students, statistics represents one of the most challenging and anxiety-provoking college courses of their entire curriculum (Zeidner, 1991). There is a general consensus among researchers that students often approach course work in statistics with fear and anxiety and that this causes students to perceive the material as more difficult than it should be (Roberts & Saxe, 1982; Sutarso, 1992). Hence, attitudes toward statistics are often negative which creates an environment in which instructional goals are difficult to achieve (Wise, 1985; Cruise, Cash & Bolton, 1985; Glencross & Cherian, 1995). Such attitudes are widely considered to serve as major obstacles to effective learning.

Traditionally, attitudes such as these have been assessed quantitatively by means of various survey instruments. The need for understanding students' attitudes toward statistics is justified by the rate of undergraduate drop-outs from introductory statistics courses, which may be as high as one-third (Del

Vecchio, 1994; Oathout, 1995). Unfortunately, little has been done to assess attitudes toward research and statistics specifically among students in the health sciences. McNamara and Green (1994) compared clinical and research attitudes among graduate psychology students pursuing either Psy.D or Ph.D. degrees and found significant differences between these two groups. Ph.D. students were found to have more positive attitudes toward research training than their Psy.D. counterparts. Specifically, Ph.D. students more strongly agreed that statistics and experimental design would be useful to them as professionals and they reported greater value in being able to critique statistical and methodological procedures. This study raises the question of whether, on the whole, individuals who select a clinical path possess less positive attitudes toward research and statistics than those who pursue laboratory and academic endeavors. The answer to this intriguing question is not known. Furthermore, no studies have been reported comparing the attitudes of students or professionals who represent various disciplines within the health sciences.

Purpose and Significance

There are numerous professional programs within the health sciences. Each discipline represents different priorities and expertise in its approach to health care. A complex interaction of educational requirements, professional opportunities and philosophical perspectives leads individuals to their chosen field. Medicine, physical therapy, occupational therapy and nursing represent vastly different disciplines within the health care system, yet these professionals must work together in an environment that is becoming more interdisciplinary

in nature. Interestingly, of these four programs at the University of New Mexico, all but the Medical School demand that their applicants take introductory statistics as a prerequisite for admission.

An implicit objective in teaching any research methodology course is to help students appreciate the subject matter by developing more positive attitudes toward statistics (Wise, 1985). All four health science programs that were investigated feature a research methodology course as part of their curricula. The purpose of this study, therefore, was to investigate the attitudes of these four student groups. Comparison of the four programs has provided information relative to the similarities and differences that occur among them.

An improved understanding of the unique attitude profiles exhibited by students from these four programs may allow educators to improve their methods of instruction. Furthermore, as research methodology is a subject that lends itself to the contemporary trend of interdisciplinary education, should future courses involve students from these different programs, an understanding of their attitudinal differences may prove to be of value to their instructors.

Research Questions

The Attitudes Toward Statistics in Medical Research (ATSMR) is a survey instrument that was developed for this study. The study was conducted to investigate the following questions:

1. Is the ATSMR a reliable measurement tool?

2. Are there differences in attitudes toward statistics regarding Affect, Cognitive Competence, Difficulty and Value among students in each of the four programs?
3. Is there a difference in overall attitude toward statistics between first and second year students in each of the four health sciences programs?
4. Are the attitude profiles different for first and second year students in each program?
5. Are the attitude profiles different for medical students who have taken an undergraduate statistics course than for those who have not?
6. Are the attitude profiles different for males and females in the medical program?

Limitations

The survey instrument which was used was a modified version of the Survey of Attitudes Toward Statistics© (Schau, Stevens, Dauphinee & Del Vecchio, 1995). This survey was designed for use with students while they are enrolled in a statistics course. However, since the respondents in this study were not enrolled in such a course at the time of the survey, rewording of some of the items was necessary. This alteration may raise doubt regarding validity of the scores from the instrument.

Definition of Terms

The following terms are defined in order to ensure clarity of this research report:

Attitude - An enduring organization of motivational, emotional, perceptual and cognitive processes with respect to some aspects of the individual's world (Kretch & Crutchfield, 1962).

Research - The study of a problem in pursuit of a definitive objective through employing precise methods with due consideration to the adequate control of factors other than the variable(s) under investigation and followed by analysis according to acceptable statistical procedures (American Public Health Association, 1957).

SATS - The Survey of Attitudes Toward Statistics©, developed by Candace Schau, et. al., The University of New Mexico, 1995. The survey consists of the following four sub-scales:

1. Affect: positive and negative feelings concerning statistics
2. Cognitive Competence: attitudes about intellectual knowledge and skills applied to statistics
3. Value: attitudes about the usefulness, relevance, and worth of statistics in personal and professional life
4. Difficulty: attitudes about the difficulty of statistics as a subject

Statistics - a mathematical way of making large amounts of data more manageable and of determining the chances of being right or wrong when a prediction is made based on the summarized data (Payton, 1988, p. 14).

Summary

As a result of major social, political and economic changes, health care providers and consumers are currently immersed in a major paradigm shift. The ways in which we provide, receive and pay for health care services in America today are vastly different than they were even ten years ago. Virtually all medical professionals are faced with difficult questions regarding their changing roles in the overall scheme of health care. The health sciences students of today will be thrust into this environment of uncertainty and will play a major role in shaping the future.

The role that research plays in health care is of critical importance. Research enlightens the clinician by providing an enhanced understanding of medical phenomena as well as the efficacy and value of new treatment approaches. It is the responsibility of all educational programs within the health sciences to foster an appreciation for medical research and methodology, as well as to provide students with the necessary skills to interpret research results. In order to accomplish this, it is imperative that students develop at least a basic understanding of statistics.

Attitudes toward statistics among university students are often negative. However, the majority of research that has been conducted in this area has focused on students in the pre-professional phase of their education or those pursuing degrees in psychology or education. No study addressing attitudes toward statistics among students in various health sciences programs has been published. An understanding of the attitudes of students in medicine, nursing, physical and occupational therapy will provide insights to those who are charged

with the task of teaching tomorrow's clinicians and researchers. The information in this study should prove valuable in curriculum planning for these four programs at the University of New Mexico and may serve as the impetus for movement toward an interdisciplinary approach to teaching research methodology

CHAPTER 2: REVIEW OF RELATED LITERATURE

Attitude is an extremely complex construct, the framework for which is both cognitive and emotional. Kretch and Crutchfield (1962, p.12) described attitude as "an enduring organization of motivational, emotional, perceptual and cognitive processes with respect to some aspects of the individual's world". Attitude can be thought of as the result of a filtering process through which ideas must pass in order to generate a perceptual representation of those ideas. The filter, itself, is the product of each individual's life experiences and his or her unique perceptions of related issues. Over the last several decades, numerous theories have been advanced regarding the social, behavioral and cognitive aspects of attitude. The following is a brief discussion of some of these theories.

Dichotomous Structure of Attitude

A somewhat simplistic view of attitude was described by Hovland, Janis and Kelley (1953). These authors proposed a Reinforcement Theory of attitude in which opinions and beliefs are thought to be the result of a specific type of verbal exchange between individuals. According to this theory, when a listener is subjected to the persuasive communication of a perceived expert, the listener will naturally adopt the attitude of the expert and thereby obtain social approval. A key component to this theory is the concept that attitude is intimately bound to a belief system of right versus wrong.

This dichotomous theme of attitude is popular among many early theories. According to Osgood and Tannenbaum (1955), attitudes tend to evolve toward maximal simplicity or polarization, either positive or negative.

Furthermore, these authors describe an associative principle whereby compatible attitude objects may exist in the same cognitive structure. If two objects with similar evaluations (either positive or negative) exist in the same cognitive structure, a harmonious condition exists. However, if two attitude objects with opposing evaluations happen to be linked in the same cognitive structure, the researchers suggested the "Principle of Congruity", whereby the evaluations of each object shift toward a point of equilibrium. Thus, attitudes toward new objects are influenced by pre-existing attitudes and vice-versa, in an ever-evolving system.

Congruity and Balance

The concepts of congruity and balance are key components in a number of attitude theories. Rosenberg (1960) and Rosenberg and Abelson (1960) describe a complex molecular system in which attitudes possess psychological structures with both affective and cognitive components. The cognitive components are arranged in a network of units where pairs of cognitive elements are linked by a specific relation. Relations, which may be positive, negative, null or ambivalent, are considered the affective components within the system. A conceptual arena consists of all cognitive elements which are associated with a given attitude object and their relations. These large conceptual arenas may be *balanced*, in which there are no inconsistent or ambivalent relations, or *imbalanced*, in which inconsistencies or ambivalence exists. It is the authors' belief that once inconsistencies are discovered through thought, individuals will try to resolve the conflict by changing one or more of the

relations within the conceptual arena or by re-defining one or more of the elements. In this way, individuals attempt to achieve a cognitive balance with respect to their attitudes (Insko, 1967).

Related to the concepts of balance and congruity in attitude structure is the notion of cognitive dissonance (Festinger, 1957). According to cognitive dissonance theory, there is a tendency for individuals to seek consistency among their cognitions (i.e., beliefs, opinions). When there is an inconsistency between attitudes or behaviors (dissonance), something must change to eliminate the dissonance. In the case of a discrepancy between attitudes and behavior, it is most likely that the attitude will change to accommodate the behavior.

Two factors affect the strength of the dissonance: the number of dissonant beliefs, and the importance of the cognitive elements involved. There are three ways to eliminate dissonance: (1) reduce the importance of the dissonant beliefs, (2) add more consonant beliefs that outweigh the dissonant beliefs, or (3) change the dissonant beliefs so that they are no longer inconsistent. Festinger claims that cognitive dissonance in individuals can be reduced either by changing their behavior or by adapting their attitude to fit a new paradigm (Insko, 1967).

Tri-Dimensional Models of Attitude

Theorists have often described attitude as having three basic dimensions: (1) a cognitive component, (2) an affective component and (3) a behavioral component (Dwyer, 1993). Triandis (1971) described the cognitive aspect of attitude as the ideas or beliefs one has relative to an attitudinal object, while the affective component relates to those feelings or emotions associated with it. The

behavioral dimension can be regarded as a propensity toward a certain type of action or response to the attitudinal object. A similar triad of attitude components has been described by other authors. According to Hassan and Shrigley (1984), attitude is composed of egocentered, social-centered and action-centered components which Greenwald (1968) described as affects, cognitions and action tendencies. All of these classification systems seem to address the same structural composition of attitude.

Other researchers have proposed a four-level structure for attitude. Fishbein and Ajzen (1975) concurred with the notion of affective (feeling) and cognitive (belief) elements but suggested that the behavioral aspect of attitude should be divided into two distinct categories: actual behavior (observable actions) and conation (behavioral intentions). The researchers went on to suggest that it is the affective dimension which is the most essential, consistent, stable and reliable measure of an individual's attitude.

Measures of Attitudes Toward Statistics

Attitudes can be measured in a variety of ways (Dwyer, 1993). Observational methods are time consuming and may be unreliable because of the inherent difficulty with inferring affective foundations or motivations from observed behaviors. Qualitative research offers the potential to assess individuals more holistically, thereby offering insight into beliefs and behavior in a sociocultural context. Assessment of attitudes via self-report methods is often preferred by educational researchers. A carefully constructed survey can identify important attitude components that, when pieced together, help researchers

understand a broader construct. Surveys can be distributed to a large number of subjects and the data obtained can be analyzed using a variety of statistical techniques. Typically, subjects are asked to respond to a series of questions or statements about an attitudinal object by expressing the degree to which they concur. A primary concern with self-reported attitude assessment, however, is that of misinformation. The manner in which respondents answer questions may be influenced by external factors such as a desire to be socially acceptable or a tendency to acquiesce - to agree with a statement when the respondent is actually unsure of his or her honest feelings (Dwyer, 1993).

During the last two decades there has been a growing interest in students' attitudes toward statistics. This is most likely the result of the increasing enrollment in basic statistics courses observed at colleges and universities throughout the world (Schau, et al., 1995). Several researchers have developed measures to assess attitude towards statistics in the interest of improving success in the classroom. Using these tools, broad generalizations have been made regarding some of the factors which may influence these attitudes; however, much is yet to be discovered regarding this complex phenomenon. Some surveys are comprehensive in their scope but their scores lack validation via factorial methods. Others are more limited and therefore do not offer a thorough explanation of the attitudes that they are intended to measure. The following is a summary of those attitude measures most frequently cited in educational literature. All of these measures are self-report assessments.

Statistics Attitude Survey (1980)

The first survey specifically dedicated to the assessment of students' attitudes toward statistics was the Statistics Attitude Survey (SAS) (Roberts & Bilderbach, 1980). This 33-item, five-point Likert-type scale was developed to better understand various aspects of statistical attitudes including the students' feelings of competence as well as the usefulness of statistics. The authors concluded that the SAS was a highly homogeneous scale that demonstrated a moderate and positive correlation with grades earned by students in a basic statistics course (Roberts & Bilderbach, 1980).

Roberts and Saxe (1982) later examined the correlation between SAS scores and other variables such as scores on a basic math test, course grade and gender, among others. The researchers determined that SAS scores had high internal consistency, with coefficient alpha values of .92 for the pre-test and .93 for the post-test. Furthermore, the researchers found that SAS scores were moderately and positively correlated with course grade and attitudes toward the course and instructor. A significant and positive change in attitude was found when comparing the scores from the beginning to the end of the basic statistics course. Students who registered for the course as an elective scored higher on the attitude scale than those for whom statistics was a requirement.

Further research was conducted using the SAS by Roberts and Reese (1987) which suggested that, although the SAS scores are highly reliable, they demonstrate low to moderate predictive validity in regard to statistics course grades or performance on statistical information post-tests. Despite the fact that the SAS includes such concepts as perceived competence and usefulness of

statistics, it was not initially thought to be factorially complex and no subscales were identified.

Attitude Toward Statistics (1985)

Perhaps the most frequently cited survey of students' attitudes toward statistics was developed by Steven Wise in 1985. The Attitude Toward Statistics (ATS) scale is a 29-item instrument featuring-five point Likert-type response options, created with the help of several introductory statistics teachers (Wise, 1985). It consists of twenty items relative to attitudes toward the field of statistics (field) and an additional nine items concerning attitudes toward the particular statistics course in which the respondents are enrolled (course). Wise initially reported that the two factors of field and course accounted for 49% of the variance in overall attitude toward statistics; however, with only ninety-two subjects, he admitted that these results should be interpreted with caution (Wise, 1985). Wise and his successors have reported coefficient alpha values ranging from .85 to .93 for scores on the course dimension and .82 to .94 for field, indicating that scores on the ATS exhibit high internal consistency (Schau, et al., 1995).

With the introduction of the ATS, Wise challenged the validity of Roberts' SAS, claiming that many of its items addressed statistical achievement rather than attitude and that its items were inappropriate for beginning students who have little or no exposure to statistics (Wise, 1985; Roberts & Reese, 1987). In fact, Wise claimed that a full one-third of the items on the SAS were invalid because they address issues such as success in solving statistics problems or

understanding statistical concepts and, consequently, that no direct empirical comparisons between scores on the SAS and his own ATS should be made (Wise, 1985). Despite this claim, comparisons between scores on the two instruments were inevitable. Roberts and Reese (1987) administered both scales to a large group of undergraduate students at Penn State University. Along with high internal consistencies for scores from both measures, the researchers found extremely high correlations between the two. Furthermore, Roberts and Reese found that scores from both scales demonstrated a similar pattern of non-correlation with various other external criteria, such as age, number of previous math and statistics courses taken and course grades.

The researchers concluded that the SAS and the ATS essentially measure the same phenomenon. Similar findings were reported by Waters, Martelli, Zakrajsek and Popovich (1988) who concluded from their high interscale correlations that scores from the two measures reflect the same attitudinal dimensions. These researchers also found a similar factorial structure for both scales and concluded that both offer information regarding two temporally stable and related aspects of attitude toward statistics: attitudes concerning the field of statistics and toward the particular statistics course being taken.

Statistical Anxiety Rating Scale (1985)

Recognizing that, for many students, taking a course in statistics can be an unpleasant experience, Cruise and Wilkins (1980) and Cruise, Cash and Bolton (1985) directed their attention to the issue of statistical anxiety with the development of the Statistical Anxiety Rating Scale (STARS). Prior to that time,

two instruments were commonly used to specifically assess mathematics anxiety: the Mathematics Anxiety Scale (Fennema & Sherman, 1976) and the Mathematics Anxiety Rating Scale (MARS) (Richardson & Suinn, 1972). However, the STARS was developed on the premise that statistics is different from math because, in addition to manipulating numbers and solving problems, it involves the further step of applying results to every-day life and making evidence-based decisions. Therefore, since statistics anxiety may involve factors which are not included in the math anxiety scales, the researchers believed that a new scale should be developed (Cruise, Cash & Bolton, 1985). Although statistical anxiety is not attitude per se, the two are closely related (Cruise, Cash & Bolton, 1985). The authors described statistical anxiety as the feelings of anxiety encountered when taking a statistics course or doing statistical analyses.

Like the SAS and the ATS, the STARS features a five-point Likert-type scale. Face validity for the 51-item survey was determined by having several faculty members and doctoral students rate whether or not each item pertained to one of six factors. These factors were identified by a principle components factor analysis and subsequent item analysis and included the following: (1) worth of statistics, (2) interpretation anxiety, (3) test and class anxiety, (4) computation self-concept, (5) fear of asking for help and (6) fear of statistics teachers (Cruise, Cash & Bolton, 1985).

Statistics Attitude Scale (1990)

Recognizing the non-traditional nature of many of their graduate students, McCall, Belli and Madjidi (1990) endeavored to improve their statistics

classroom outcomes by investigating attitudes toward statistics and relating them to student temperament. The researchers used the Kiersey Temperament Sorter (Kiersey & Bates, 1984) and devised their own survey addressing statistics attitude, the Statistics Attitude Scale. This instrument consisted of twenty items in a five-point Likert-type format. Early factor analysis yielded three factors; however, this was performed on data obtained from only 26 subjects (McCall, Belli & Madjidi, 1990). No relationship was found between attitudes toward statistics and student temperament.

Later studies performed by Glencross and Cherian in 1992 and 1995 using the Statistics Attitude Scale revealed a somewhat different factorial structure than was originally reported. When these researchers used the Statistics Attitude Scale to investigate attitudes among postgraduate students in Transkei, South Africa, they found the scores on the scale to have high internal consistency (Cronbach's alpha = .95). Furthermore, they concluded that this scale is reflective of a unidimensional construct (Glencross & Cherian, 1992). The same factorial structure featuring a dominant first component was found in a subsequent study by the same researchers in the Lebowa region of South Africa (Glencross & Cherian, 1995). These studies demonstrated that the Statistics Attitude Scale of McCall, Belli and Madjidi, although developed in the United States, functioned well in a very different cultural setting.

Multifactorial Scale of Attitude Toward Statistics (1991)

Critical of her predecessors who had introduced scales that measured attitude as a unidimensional construct, Auzmendi developed the Multifactorial

Scale of Attitude Toward Statistics (1991). Recognizing the significance of attitude, Auzmendi stated, "It is important to improve the present level of statistics achievement. But it is more important to change the students' attitudes" (Auzmendi, 1991, p.4). Based on the factorial structure of several mathematics attitude scales, Auzmendi chose five possible dimensions of attitudes toward statistics to investigate: Enjoyment, Anxiety, Motivation, Confidence and Usefulness.

Auzmendi's original forty-item scale was paired-down after a principal-components factor analysis with varimax rotation identified twenty-five items for assessing the five dimensions. These items were encorporated into a Likert-type scale with five ordered response options for assessing the five hypothesized dimensions (5 items per factor). Coefficient alpha values for scores from the five factors ranged from .60 for Motivation and Usefulness to .84 for Confidence. Concurrent validity was supported by a Pearson product-moment correlation of .86 between total scores on the Multifactorial Scale and Roberts' SAS.

Statistics Anxiety Inventory (1991)

Like Cruise, Cash and Bolton, Moshe Zeidner elected to explore the issue of statistics anxiety. His premise was that statistics anxiety is most likely the result of various affective, social and cognitive factors acting in concert and he likened it to a form of performance anxiety characterized by excessive worry, poor concentration, stress and its associated physiologic changes. For many students, Zeidner believed that anxiety may debilitate their level of performance (Zeidner, 1991).

For his survey, the Statistics Anxiety Inventory (SAI), Zeidner conceptualized a two-factor structure with components of test anxiety and content anxiety. He patterned it after the MARS (Richardson & Suinn, 1972) with two primary dimensions: anxiety about statistics content (content) and anxiety about statistics performance and problem-solving (test). The survey was distributed to a sample of students who had previously taken and passed an introductory statistics course. Scores from this instrument were found to have high internal consistency with a Cronbach's alpha of .94 for the composite score and .94 and .92, respectively, for the content and test components. Factor analysis suggested that the two-factor construct model was appropriate, accounting for 45% of the total item variance. According to Zeidner, there exists a correlation between statistics anxiety and performance deficits; however, the issue of causality concerning this relationship is ambiguous (Zeidner, 1991).

Survey of Attitudes Toward Statistics© (1995)

According to Schau, et al. (1995), in order to provide useful information for those involved in statistics education, an attitude survey should adequately distinguish between various dimensions of attitude toward statistics and be flexible enough to be pertinent throughout the duration of a statistics course. Furthermore, such surveys should be relatively short to command a minimum amount of class time and contain both positively and negatively worded items. The development of such a survey should also involve students' input and its internal structure should be validated via confirmatory analysis techniques. Until

Schau and her associates introduced the Survey of Attitudes Toward Statistics (SATS), no published statistics attitude scale had satisfied all of the above criteria.

During the initial stage of the SATS development, the researchers solicited the help of both introductory statistics students as well as instructors to develop a list of key concepts that represent students' attitudes toward statistics (Schau, et al., 1995; Harris & Schau, 1999). Item concepts selected from existing instruments were also included in the initial item list. Each item concept was then sorted by panel consensus into one of four dimensional categories: A) Affect - positive and negative feelings concerning statistics; B) Cognitive Competence - attitudes about intellectual knowledge and skills applied to statistics; C) Value - attitudes about the usefulness, relevance, and worth of statistics in personal and professional life; and D) Difficulty - attitudes about the difficulty of statistics as a subject (Schau, et al., 1995).

A pilot version of the SATS composed of 32 items was then administered to 1403 introductory statistics students, 230 of whom were also asked to complete Wise's ATS (1985). An exhaustive item analysis was performed utilizing traditional methods (item-total and squared multiple correlations) as well as an item-based confirmatory factor analysis which resulted in the elimination of four items. Scores from the final form of the 28-item SATS yielded coefficient alphas ranging from .81 to .85 for Affect, .77 to .83 for Cognitive Competence, .80 to .85 for Value and .64 to .77 for Difficulty. Concurrent validity was established by examining the Pearson product-moment correlation coefficients between the SATS subscale scores and the ATS scores. All pairwise correlations were found to be significant and positive except for the one between the ATS Field score and

the SATS Difficulty score. The authors concluded that the SATS provides a useful and reliable measure of four distinct aspects of students' attitudes toward statistics (Schau, et al., 1995).

Attitudes Toward Statistics and Other Related Factors

The instruments discussed in the previous section of this paper have been used to identify possible relationships between attitudes toward statistics and other educational and personal factors. For example, researchers have investigated the possible links between statistics attitudes and such student characteristics as math experience (Roberts & Saxe, 1982; Sutarso, 1992), attitude toward math (Roberts & Saxe, 1982; Zeidner, 1991; Sutarso, 1992), ethnicity (Sutarso, 1992) and personality (McCall, Belli & Madjidi, 1990). The following is a review of the literature regarding two such issues: gender and achievement/persistence.

Statistics Attitude and Gender

As is the case with general college enrollment today, a typical statistics course is likely to have more females than males (Harris & Schau, 1999). Several attempts have been made to identify differences in attitudes toward statistics between males and females; however, there is a lack of agreement among researchers regarding the existence of gender differences. Roberts and Saxe (1982) found that males scored higher on the SAS than did females and thus concluded that males generally have more positive attitudes. Other researchers have challenged this assertion, however. Elmore and Vasu (1986) showed more

positive attitudes among female students than males on Wise's ATS measure. This finding was also supported by Raiszadeh and Ahmadi (1987). Concerning statistics anxiety, Zeidner (1991) found an interesting relationship pattern. Females were identified as having greater statistics test anxiety while males demonstrated higher statistics content anxiety.

The majority of research examining gender and attitudes toward statistics has identified no difference between males and females. Using the ATS scale, Waters, Martelli, Zakarajsek and Popovich (1988, 1989) found no attitude differences in two separate studies when measured both at the beginning and the end of an introductory statistics course. Other researchers who have found no differences in attitude between males and females include Auzmendi (1991), Sutarso (1992) and Cherian and Glencross (1997). A relationship between attitude toward statistics and gender has not been consistently demonstrated.

Statistics Attitude and Achievement/Persistence

Unlike gender, there appears to be widespread agreement among researchers concerning the relationship between achievement and attitude toward statistics. Roberts and Saxe (1982) as well as Wise (1985) demonstrated significant and positive correlations between SAS scores and grades, particularly when measured at the end of a statistics course. Using the ATS, Wise (1985) also found that course grade correlated positively with his course subscale score but not with attitude toward the field of statistics. Waters, et al. (1988) found significant and positive correlations between course grade and scores on both the SAS and the ATS. Furthermore, using the ATS and a basic statistics skills post-

test, Elmore, Lewis and Bay (1993) reported that the proportion of variance in achievement accounted for by attitude toward statistics was large.

Similar findings have been reported regarding statistics anxiety and achievement. Sutarso (1992) found that the higher the statistics anxiety, the lower the course grade. Ware and Chastain (1989) identified relationships between attitude, anxiety and achievement. The authors demonstrated that more positive attitude scores were associated with lower anxiety and higher achievement scores. A weak, negative correlation between statistics anxiety and course grade was identified by Zeidner (1991), with those reporting higher levels of anxiety achieving slightly lower grades.

Related to the issue of statistics achievement are those of persistence and course completion. Utilizing Schau's SATS, Del Vecchio (1994) found that for non-hispanic white undergraduate students, Cognitive Competence was the unique dimension of attitude that was most closely related to course completion. Those students who showed greater confidence in their statistics abilities were more likely to pass their introductory statistics course. Interestingly, the author reported that there was a strong gender effect in her findings, with this relationship more than twice as strong for females than for males.

Research and Statistics in Health Science Education

There appears to be a commitment toward instruction of basic research methodology among health science education programs in the U.S. today. The vast majority of programs in medicine, nursing, and physical and occupational therapy across the country require their students to complete a research

methodology course in some form as a condition for graduation. The actual amount of time dedicated to statistical design and analysis within these courses, however, is highly variable. The following section addresses the issue of how research and statistics are presented in the four health science fields.

Medical Schools

Despite an explosion of medical knowledge resulting in competition among various disciplines to occupy greater amounts of the medical curriculum, the percentage of medical schools in the U.S. that require their students to take a course in statistics has not changed over the last thirty years (Colton, 1998). The most recent study of the role which statistics plays in medical education was performed by Looney, Grady and Steiner (1998). The researchers surveyed all 125 schools listed in the Association of American Medical Colleges' Directory of American Education; 100 of the schools (80%) responded to the survey. None of these programs reported that they require a prerequisite statistics course. However, 83 of the schools offer an introductory biostatistics unit; it is a required unit for 74 of these schools. The range of class time devoted to biostatistics in these programs is from 2 to 48 hours (median = 20); only 25% of these programs meet the minimum requirement of 30 hours suggested by Hopkins (1958) as necessary to achieve a basic understanding of statistics concepts for medical students. Class sizes vary widely, from 40 to 265 students (median = 134) and a majority of these courses are taught by a non-M.D. (Looney, Grady & Steiner, 1998).

Looney and his associates also found that more than half of the medical programs which require biostatistics (38/74; 51%) reported that the primary course objective was "understanding basic concepts of biostatistics" while 32% (24/74) selected "evaluation of medical literature" as their main emphasis. Only 19% (14/74) included instruction on the use of computers in statistical analysis or for database management (Looney, Grady & Steiner, 1998).

The faculty in this study were also asked to rate their perceptions of the students' attitudes toward the course after its completion; 12% reported "Very Favorable", 46% "Favorable", 24% "Neutral", 18% "Unfavorable" and 1% "Very Unfavorable" (Looney, Grady & Steiner, 1998). According to Colton (1998), there has been a decline in instructors' perceptions of unfavorable attitudes among students from 35% in 1969 to 19% in 1993. He suggested that this change may be explained by (1) improved teaching skills; (2) a recognition among medical students of the need for a basic understanding of statistics; and (3) a more positive self-image among those who teach statistics in medical schools. It should be noted, however, that while medical school faculty may be reporting an improvement in attitudes toward statistics among the students, no research has been published which describes these attitudes as reported by the students, themselves.

Although further improvements can still be made in the area of statistics education for medical students, some progress has been achieved (Marshall & Smith, 1981). The expanding role of statistics in medical research has resulted in the inclusion of more statisticians among the full-time faculty of medical programs. Furthermore, there has been an increase in the number of individuals

who are dually certified in both medicine and statistics. The result is a growing cadre of physicians who also have statistical credentials (Colton, 1998). This evidence suggests that statistics education is firmly entrenched - perhaps even expanding - in contemporary medical training.

Nursing Schools

Nursing research in the U.S. was not initiated until the 1950s and it was not until late in that decade that the focus of nursing studies was turned toward clinical problems (Roode, 1987). In response to growing concerns regarding a lack of consistency between the educational curricula of nursing programs across the country, a 1979 task force appointed by the National League for Nursing (NLN) developed a list of competencies which were expected of all nursing school graduates. Among those competencies set forth by the task force was that nursing students participate within a structured role in research (NLN, 1979 Pub. No. 14-1905). That same year, the NLN's accreditation committee adopted a new set of guidelines which included the requirements that all graduates of baccalaureate nursing programs must have an understanding of the research process and its contribution to nursing practice and the ability to evaluate research for the applicability of its findings to nursing actions (NLN, 1979 Pub. No. 15-1758).

Priorities for nursing research were set in 1981 by the American Nurses' Association. They include the following:

1. Promoting health
2. Preventing health problems
3. Decreasing the negative impact of health problems on coping abilities, productivity and life satisfaction

4. Ensuring that the care needs of vulnerable groups, such as the aged, are met through appropriate strategies
5. Designing and developing health care systems that are cost-effective in meeting the nursing needs of the population
6. Promoting health, well-being and competency for personal health in all age groups (ANA, 1981)

In spite of a clear mandate for an increase in nursing research, there remain numerous barriers to scientific study in the nursing professions. These obstacles include the complex nature of clinical problems and a general lack of understanding of the multivariate, multimethod designs needed to analyze them (Shortridge, 1987).

According to Roode (1987) graduates of baccalaureate nursing programs should be knowledgeable consumers of research and have the responsibility of recognizing those nursing problems that need to be investigated, whereas graduates of advanced-degree programs should be prepared to conduct research. Nursing programs across the country have responded by increasing their statistics requirements. Stokes, Whitis and Moore-Thrasher (1997) surveyed all NLN-accredited master's programs which focus on adult health nursing receiving a 73% response rate (85/116). Seventy-eight percent of these programs reported having a basic statistics prerequisite. Furthermore, research and statistics were listed among the most prevalent core-courses in these programs, although specific percentages were not included. This evidence suggests that the nursing profession is placing a high priority on research education.

Physical and Occupational Therapy Programs

Programs in both physical and occupational therapy throughout the U.S. also appear to be making efforts to emphasize the role of research in their

respective curricula. In light of the rapidly changing responsibilities of today's clinicians, both the American Physical Therapy Association and the American Occupational Therapy Association have repeatedly issued mandates for an increase in evidence-based clinical practice. This approach to patient care is dependent on clinical research, particularly in the areas of outcome assessment and clinical measurement. Consequently, there has been an increasing emphasis on research methodology and statistical analysis in PT and OT programs.

In 1991, 46% of OT programs in the U.S. required basic statistics as a prerequisite for admission (Marshall, 1991). In an investigation of current Web sites for PT and OT programs across the country conducted for this project, a random sample of 30 OT school Web sites revealed that 90% of the programs now require a statistics prerequisite and 97% include a research methodology course in their curricula. Of the 107 PT programs investigated, 85% feature a statistics prerequisite and 98% include a required research methodology course. This is consistent with the accreditation guidelines of both professions which include strong commitments toward research education. There has been no research published regarding the attitudes of either PT or OT students toward research and statistics.

Summary

Numerous researchers and scholars have attempted to describe a theoretical framework for attitude. Most have characterized this complex entity as a polar phenomenon with associative qualities and a social influence. Attitudes appear to be somewhat adaptable with an overall natural human orientation

toward balance and congruity. Most authors describe attitude as a complex interaction of cognitive, affective and behavioral dimensions.

Attitudes toward statistics among college students have been examined for nearly twenty years. Several scales have been developed to measure this phenomenon. Researchers have learned that there is a relationship between attitudes and achievement in the introductory statistics classroom and that there is little evidence to suggest that there are differences in attitudes between males and females. Although most students in the health sciences are required to take introductory statistics, no studies have been reported that examine overall attitudes toward statistics or the relationship between attitudes and degree program for this population.

It is clear that educational programs in the health sciences are making a strong commitment toward inclusion of statistics and research methodology in their curricula. There exists a need for a greater understanding of the attitudes which these students bring to the classroom so that efforts can be made to facilitate a culture of health practitioners who are more skilled in research and literature consumption.

CHAPTER 3: METHODS

The purpose of this study was to investigate attitudes toward statistics among health sciences students in the medical, nursing, and physical (PT) and occupational therapy (OT) programs at the University of New Mexico (UNM). Specifically, this investigation measured attitude differences and similarities in the areas of Affect, Cognitive Competence, Difficulty and Value by academic year for each program. A further objective was to determine possible relationships between attitudes toward statistics, gender and previous statistics experience among the medical student population. This chapter presents information on the subjects, survey instrument, pilot, procedures and data analysis that were used.

Subjects

The survey was completed by 272 students enrolled in four health sciences programs at UNM. Table 1 shows the distribution of respondents by program, academic year and gender.

		Academic Year		Gender	
Program	n	First (%)	Second (%)	Male (%)	Female (%)
Medical	124	63 (51)	61 (49)	52 (42)	72 (58)
Nursing	45	25 (56)	20 (44)	5 (11)	40 (89)
PT	55	28 (51)	27 (49)	14 (25)	41 (75)
OT	48	23 (48)	25 (52)	7 (15)	41 (85)
TOTAL	272	139 (51)	133 (49)	78 (29)	194 (71)

Table1. Survey respondents by program, academic year and gender.

Although participation was voluntary, over 85% of the students enrolled in the medical, PT and OT programs as well as approximately 40% of the nursing students were represented in the survey sample. Both male and female students were surveyed; however, since the vast majority of students in the PT, OT and nursing programs were female, gender was only considered in the analysis for the medical student sample. Furthermore, all respondents from the PT, OT and nursing schools had taken introductory statistics as a prerequisite for admission to their respective programs. However, because the medical school at UNM does not require an undergraduate statistics course, 63 (51%) medical students reported that they had never taken a statistics course while 61 (49%) of them had. Thus, prior experience in statistics was considered in the analysis of the medical student data only.

Instrument

Based on the SATS© (Schau, et al., 1995), the Attitudes Toward Statistics in Medical Research (ATSMR) consists of thirty-two items which offer seven Likert response options (1=strongly disagree, 4=neither agree nor disagree, 7=strongly agree) measuring four attitude dimensions: Affect, Cognitive Competence, Difficulty and Value. The SATS© was chosen as the basis for the ATSMR because of its complex factorial structure which has the potential to provide useful information regarding students' attitudes toward statistics to those who are responsible for their education. However, this survey was designed to be used with students who are presently enrolled in a statistics course. Therefore,

modification of some of the SATS© items was necessary in order to make them appropriate for health science students who are not enrolled in a statistics course at the time of the survey. Furthermore, of interest to this researcher is attitude as it relates to the use and interpretation of statistics in medical literature rather than actual statistical computation. Therefore, items from the original SATS© were modified to reflect this slightly different construct.

A panel of four instructors from the physical and occupational therapy faculty was assembled to edit and then sort each of the items of the ATSMR into one of the four dimensions: Affect, Cognitive Competence, Difficulty and Value. Consensus was reached on all items.

In addition to the ATSMR, a background/demographics cover sheet was included which asked the respondents to identify the following:

1. The last 5 digits of the subject's Social Security number
2. Gender
3. Program
4. Academic year
5. Age
6. Perceived math ability
7. Undergraduate statistics course(s) taken and grade(s) received
8. Rating of most recent undergraduate statistics course
9. Rating of instructor from most recent undergraduate statistics course

The ATSMR along with a copy of the information cover sheet can be found in Appendix A. The individual items from the ATSMR sorted by attitude type are presented in Appendix B.

Pilot

Prior to administering the survey to the target groups, a pilot study was conducted using 51 first year PT and OT students in order to identify any

unforeseen problems or misunderstandings with the instrument. Reliability of the instrument was investigated by examining the internal consistencies of scores from the survey and its subscales using Cronbach's Alpha. Alpha values for the survey and each of its subscales were greater than .65 and respondents reported no ambiguities in the survey items. Therefore, no revisions to the original survey were deemed necessary based on either the pilot data or respondent feedback. Data from the pilot group were not included in the final study.

Procedure

After approval for the study was obtained from the appropriate Institutional Review Board, instructors for the four health science programs were contacted and given a brief description of the project along with a copy of the survey. During the spring semester of 1999, male and female students who were enrolled in either their first or second year of education in the physical therapy, occupational therapy, medical and nursing programs at The University of New Mexico (UNM) were asked to complete the ATSMR. Student participation was optional. Prior to completing the survey, the students were asked to read and sign a standard consent form.

Statistical Analysis

Two types of students can inappropriately impact the analysis results: non-participants and statistical outliers. Non-participants were defined as students who elected not to participate, did not complete at least 80% of the

survey, or did not provide the necessary background information on the cover sheet. Based on these criteria, there were no non-participants in this study.

The distribution of attitude scores for each of the subscales was examined within each program by academic year interaction cell for possible distributional problems. Values for skewness and kurtosis for each distribution were examined. According to Finch, West and MacKinnon (1997) the assumption of distributional normality is violated when the value for skewness exceeds 2 and kurtosis exceeds 7. Univariate outliers were defined as those subjects whose scores fell more than three standard deviations from the mean score of their cell and were discontinuous from their closest neighbors. These subjects were eliminated from the analysis. Multivariate outliers and influential cases were determined by running regression with all independent variables and subscale scores in the model and examining Cook's distance and Studentized deleted residuals. Four separate regression equations were used with each subscale score entered as the dependent variable. Any subject with a Studentized deleted residual value which was greater than 3 and discontinuous from its closest neighbor was considered a poor model fit and eliminated accordingly. Likewise, any subject who demonstrated a Cook's Distance which was discontinuous with its closest neighbors was considered an influential case and removed from the analysis. Once the outliers were removed, the reliability of the scores from attitude measure and each of its subscales was examined using Cronbach's alpha.

Using SPSS 6.1 for the Macintosh, a separate split-plot analysis was performed for each of the academic programs with attitude subscale scores as the repeated factor and academic year as the between-subjects factor. All

possible interactions were tested. An additional split-plot ANOVA was then conducted with the medical student data. In this analysis, attitude was entered as the within-subjects variable; gender, previous experience with statistics and academic year were the between-subjects factors. All possible interactions were examined. For all analyses, an alpha level of .05 was used for significance, with Bonferroni adjustments for simple effects and all needed Tukey's post-hoc tests. The Tukey method of mean comparisons was chosen because of the unbalanced design and because, according to Stevens (1986), it is more powerful when the Greenhouse-Geisser Epsilon exceeds .7. Effect sizes were also calculated for all significant pairwise comparisons using the root mean square of the population variance. According to Cohen (1988), effect sizes of greater than .8 are considered large, whereas those of .5 to .8 are medium. Effect sizes of less than .5 are small.

Summary

A large and representative sample of students in four health sciences programs at UNM completed the ATSMR survey. The data were screened for non-participants and statistical outliers and the reliability of the scores from the instrument was investigated using Cronbach's alpha. Separate split-plot analyses were then performed for each academic program with attitude as the within-subjects variable and academic year as the between-subjects variable. A final split-plot analysis was conducted with the medical student data using gender, prior experience with statistics and academic year as the between-subjects

variables and attitude as the within-subjects variable. All possible interactions were considered in each of the analyses.

CHAPTER 4: RESULTS

A separate split-plot ANOVA was performed on the ATSMR data set for each academic unit. This chapter begins with an evaluation of distributional assumptions followed by a section on reliability of scores from the ATSMR. Results of the survey are then presented in the following program order: medical, nursing, physical therapy and occupational therapy. The final section contains the results of an additional split-plot ANOVA performed on the medical student data using gender, academic year and previous experience with undergraduate statistics as the between-subjects variables and attitude as the within-subjects variable.

Distributional Assumptions

Responses to all negatively worded items were reversed prior to beginning the analyses. There were three cases in which incomplete data were obtained. In each case, only a single item was neglected. This problem was managed by substituting each subject's mean score for the subscale to which the missing item belonged. Thus, no subject was removed on the basis of missing data. Descriptive statistics were then calculated for each of the four academic programs and the univariate distributions of the attitude subscale scores were grouped into program by year interaction cells. After the means and variance estimates of the four measures were calculated for each cell, the distributions were examined to identify univariate outliers. Only one respondent, a junior PT student, was found to have a subscale score that was greater than three standard

deviations from her cell mean. An exceptionally low score on the value subscale warranted her removal from the study resulting in a survey sample of 271 subjects.

With the univariate outlier removed, multiple regression was used to identify potential multivariate outliers. Four separate regression equations were tested, using each of the attitude subscales as the dependent variable. The independent variables for each test were program and year and their interaction, as well as the remaining three attitude subscale scores that were centered around their means. Analysis of residuals yielded six multivariate outliers based on the criteria described in Chapter 3. These subjects were removed, resulting in a final analysis sample of 265. Table 2 shows demographic information and subscale scores for each of the multivariate outliers as well as their cell means. After removal of all outliers, a repeat examination of the distributions in the program by year interaction cells revealed no remaining univariate outliers and values for skewness and kurtosis which were all within acceptable levels as outlined in Chapter 3.

For each of the four analyses performed, Mauchly's test of sphericity was found to be significant ($p<.005$). To control for the inflated univariate significance which occurs in this situation, the Greenhouse-Geisser Epsilon adjustment to the degrees of freedom was used in the tests of the repeated measures effects.

	Program	Year	Gender	Affect (M)	CC (M)	Value (M)	Diff (M)
1.	PT	2	M	**4.0** (4.0)	**6.7+** (4.4)	**6.4** (5.5)	**4.6** (4.1)
2.	OT	1	F	**3.3+** (3.9)	**6.0** (4.4)	**6.1** (5.7)	**4.3** (3.9)
3.	Medical	1	F	**1.9+** (4.2)	**5.0** (5.0)	**6.6** (6.1)	**4.2** (4.0)
4.	OT	1	M	**5.0** (3.9)	**5.3** (4.4)	**3.1+** (5.7)	**4.8** (3.9)
5.	OT	2	F	**2.7** (3.3)	**4.1** (4.3)	**4.4** (6.0)	**1.3+** (3.2)
6.	Medical	1	F	**3.7** (4.2)	**4.9** (5.0)	**7.0** (6.1)	**6.1+** (4.0)

Table 2. Values for the six multivariate outliers (marked with a +) and their program by year cell means.

In none of the four analyses was the multivariate test for homogeneity of dispersion matrices (Box's M) found to be statistically significant. However, the univariate assumption of homogeneity of variance was violated on the Value scale for PT students, Bartlett-Box $F(1,7795)=4.92$, $p=.03$. When cell sizes are approximately equal as in this case, the F test is robust (Stevens, 1988). Therefore, no adjustments were made within the analysis. All other program by attitude distributions met the criterion of univariate homogeneity of variance.

Reliability

Upon completion of the data screening, the reliability of scores from the ATSMR and its four subscales was examined. The overall and subscale alpha values for each program are presented in Table 3. The range of reliability scores was .64 to .95 with only one value below .70 (Difficulty for medical students). If removed, no single item would increase the alpha value by more than .04. Therefore, the survey subscale scores were considered to have acceptable internal consistency and no items were eliminated from the subscales.

	Overall	Affect	Cognitive Competence	Value	Difficulty
Medical	.90	.88	.81	.79	.64
Nursing	.95	.92	.87	.89	.80
OT	.89	.88	.78	.72	.71
PT	.92	.90	.87	.73	.77
Overall	.92	.90	.83	.81	.72

Table 3. Coefficient alpha values for each academic program.

Program Profiles

Separate split-plot ANOVAs were performed to examine the attitude profiles for each of the four academic programs. For each test, attitude with its four levels constituted the within-subjects variable and academic year served as the between-subjects variable. Table 4 shows the mean and standard deviation estimates on the four subscale scores for first and second year students in each program.

The interaction between attitude and year was also examined. For all tests, an alpha level of .05 was used for significance, adjusted to .025 for simple effects and Tukey's post-hoc analyses.

	Affect SD	Cognitive Competence SD	Value SD	Difficulty SD	n
Medical					
First Year	**4.19**	**4.96**	**6.07**	**4.01**	**61**
	1.17	.97	.69	.69	
Second Year	**3.79**	**4.49**	**5.96**	**3.91**	**61**
	1.00	.88	.63	.69	
Both Years	**3.99**	**4.73**	**6.01**	**3.96**	**122**
	1.10	.95	.66	.69	
Nursing					
First Year	**4.11**	**4.80**	**5.54**	**3.81**	**25**
	1.46	1.19	1.07	.94	
Second Year	**3.76**	**4.34**	**5.56**	**3.71**	**20**
	1.14	1.06	.94	.85	
Both years	**3.94**	**4.57**	**5.55**	**3.76**	**45**
	1.33	1.15	1.00	.90	
PT					
First Year	**3.93**	**4.75**	**5.70**	**3.72**	**27**
	1.09	.96	.55	.85	
Second Year	**3.98**	**4.40**	**5.47**	**4.06**	**26**
	1.22	1.09	.85	.77	
Both Years	**3.96**	**4.57**	**5.59**	**3.89**	**53**
	1.14	1.03	.72	.82	
OT					
First Year	**3.89**	**4.42**	**5.71**	**3.89**	**21**
	1.04	1.03	.68	.78	
Second Year	**3.29**	**4.25**	**6.01**	**3.21**	**24**
	1.02	.82	.79	.68	
Both Years	**3.59**	**4.34**	**5.86**	**3.55**	**45**
	1.06	.92	.75	.80	

Table 4. Unweighted Subscale means and standard deviations (based on weighted means) for first and second year students in the four academic programs.

Medical Students

Table 5 shows that the test of the interaction of year and attitude was not statistically significant for the medical students. However, a statistically significant main effect of attitude was found. As shown in Table 6, Tukey's post-hoc analysis for mean scores on the four attitude items showed significant differences in all pairwise comparisons except one. Value subscale scores were significantly more positive than Cognitive Competence, Affect and Difficulty scores. Cognitive Competence scores were significantly more positive than both Affect and Difficulty scores. All effect sizes were large. No difference was found between the mean Affect and Difficulty scores.

Source	Partial η^2	SS	df	MS	F	p
Between-Subjects Effects:						
Year	.043	8.88	1	8.88	5.42	.022
Error		196.59	120	1.64		
Within-Subjects Effects:						
Attitude	.683	337.91	3 (2.11)	112.64	258.53	<.0005
Year x Attitude	.022	3.51	3 (2.11)	1.17	2.69	.067
Error		156.85	360 (253.74)	.44		

Table 5. Source Table for Medical student data. (Adjusted degrees of freedom are given in parentheses).

	Value (M=6.01)	**Difficulty** (M=3.96)	**Affect** (M=3.99)
Cognitive Competence (M=4.73)	Tukey a=21.43 d=1.94	Tukey a=12.72 d=1.15	Tukey a=12.24 d=1.11
Affect (M=3.99)	Tukey a=33.67 d=3.05	No Significant Difference	
Difficulty (M=3.96)	Tukey a=34.15 d=3.09		

Table 6. Tukey pairwise significance test results (Tukey a) and effect sizes (d) for Medical student data; all p values < .05 adjusted to .025 unless otherwise noted.

As a main effect, year was also statistically significant. Overall, the first-year students (M=4.81) had more positive attitudes toward statistics than the second-year students (M=4.54), d=.21, a small effect size.

Nursing Students

Table 7 shows that neither the interaction between year and attitude nor the main effect of year were statistically significant. However, the main effect of attitude was statistically significant. Examination of the data for the nursing students revealed a very similar pattern of significance among the four mean attitude subscale scores as was found for the medical students.

As shown in Table 8, Tukey's post-hoc analysis revealed significantly more positive attitudes regarding the Value of statistics than all other attitude types. Additionally, attitudes among the Nursing students regarding their Cognitive Competence were significantly more positive than those for Affect

and Difficulty of statistics. Effect sizes for these comparisons were all large. No difference was found between mean Affect and Difficulty scores.

Source	Partial η^2	SS	df	MS	F	p
Between-Subjects Effects:						
Year	.015	2.23	1	2.23	.65	.425
Error		147.40	43	3.43		
Within-Subjects Effects:						
Attitude	.578	87.03	3 (2.28)	29.01	58.92	<.0005
Year x Attitude	.025	1.64	3 (2.28)	.55	1.11	.340
Error		63.52	129 (98.13)	.49		

Table 7. Source Table for Nursing student data. (Adjusted degrees of freedom are given in parentheses).

	Value (M=5.55)	**Difficulty** (M=3.76)	**Affect** (M=3.94)
Cognitive Competence (M=4.57)	Tukey a=9.40 d=1.40	Tukey a=9.79 d=1.46	Tukey a=6.06 d=.90
Affect (M=3.94)	Tukey a=15.46 d=2.30	No Significant Difference	
Difficulty (M=3.76)	Tukey a=19.16 d=2.86		

Table 8. Tukey pairwise significance test results (Tukey a) and effect sizes (d) for Nursing student data; all p values < .05 adjusted to .025 unless otherwise noted.

Physical Therapy Students

The same pattern of significance that was seen with the Nursing students was discovered among the PT data (Table 9). Only the main effect of attitude was statistically significant. As was seen in both the Medical and Nursing programs, Tukey's post-hoc analysis revealed significantly more positive attitudes regarding the Value of statistics than all other attitude types including Cognitive Competence, Affect and Difficulty. Furthermore, attitudes among PT students regarding their Cognitive Competence were significantly more positive than those for Affect and Difficulty of statistics. Again, these effect sizes were large. No difference was found between mean Affect and Difficulty scores (Table 10).

Source	Partial η^2	SS	df	MS	F	p
Between-Subjects Effects:						
Year	.001	.11	1	.11	.05	.824
Error		109.45	51	2.15		
Within-Subjects Effects:						
Attitude	.578	97.88	3 (2.11)	32.63	69.95	<.0005
Year x Attitude	.050	3.78	3 (2.11)	1.24	2.66	.071
Error		71.37	153 (107.44)	.47		

Table 9. Source Table for Physical Therapy student data. (Adjusted degrees of freedom are given in parentheses).

	Value (M=5.59)	Difficulty (M=3.89)	Affect (M=3.96)
Cognitive Competence (M=4.57)	Tukey a=10.73 d=1.47	Tukey a=7.23 d=.99	Tukey a=6.55 d=.90
Affect (M=3.96)	Tukey a=17.28 d=2.37	No Significant Difference	
Difficulty (M=3.89)	Tukey a=17.96 d=2.47		

Table 10. Tukey pairwise significance test results (Tukey a) and effect sizes (d) for PT student data; all p values < .05 adjusted to .025 unless otherwise noted.

Occupational Therapy Students

Table 11 shows that the comparison of scores for the Occupational Therapy students revealed a similar basic pattern to the other three programs. However, unlike the other three programs, the OT students demonstrated a statistically significant interaction between year and attitude. Simple effects analysis demonstrated that attitude type was significantly related to attitude scores for both first-year and second-year students. Tukey's post-hoc analysis for the first-year OT students showed significant large pairwise differences between Value and each of the other three measures. No other pairwise comparisons were significant for the first-year OT students (Table 12).

Source	Partial η^2	SS	df	MS	F	p
Between-Subjects Effects:						
Year	.048	3.68	1	3.68	2.16	.149
@ Affect	.081	3.99	1	3.99	3.78	.058
Error		45.45	43	1.06		
@CC	.009	.33	1	.33	.39	.537
Error		36.60	43	.85		
@Value	.042	1.02	1	1.02	1.88	.178
Error		23.38	43	.54		
@Difficulty	.184	5.17	1	5.17	9.69	.003
Error		22.93	43	.53		
Error		73.09	43	1.07		
Within-Subjects Effects:						
Attitude	.739	156.33	3 (2.42)	52.11	121.62	<.0005
First year	.456	46.33	3 (2.42)	15.44	36.05	<.0005
Second year	.688	121.87	3 (2.42)	40.62	94.81	<.0005
Year x Attitude	.110	6.84	3 (2.11)	2.28	5.32	.004
Error		55.27	103.91	.43		

Table 11. Source Table for Occupational Therapy student data. (Adjusted degrees of freedom are given in parentheses).

	Value (M=5.71)	**Difficulty** (M=3.89)	**Affect** (M=3.89)
Cognitive Competence (M=4.42)	Tukey a=8.99 d=1.96	No Significant Difference	No Significant Difference
Affect (M=3.89)	Tukey a=12.71 d=2.77	No Significant Difference	
Difficulty (M=3.89)	Tukey a=12.68 d=2.77		

Table 12. Tukey pairwise significance test results (Tukey a) and effect sizes (d) for first-year OT student data; all p values < .05 adjusted to .025 unless otherwise noted.

For the second-year OT students, Tukey's post-hoc comparisons found the same pattern of significance that was discovered for the students of the other three programs (Table 13). Value subscale scores were significantly more positive than all others. Additionally, Cognitive Competence scores were significantly more positive than both Affect and Difficulty scores. There was no significant difference in mean scores for Difficulty and Affect.

Simple effects analyses also revealed that, for the OT students, year was related to attitude on the Difficulty subscale only. First-year OT students (M=3.89) demonstrated attitudes which suggest that they find statistics easier than the Second-year OT students (M=3.21), d=1.28, a large effect size.

As a main effect, type of attitude was strongly related to attitude score; however, attitude type should not be interpreted as a main effect since it was involved in a significant interaction with year.

	Value (M=6.01)	Difficulty (M=3.21)	Affect (M=3.29)
Cognitive Competence (M=4.25)	Tukey a=13.13 d=2.68	Tukey a=7.73 d=1.58	Tukey a=7.15 d=1.46
Affect (M=3.29)	Tukey a=20.28 d=4.14	No Significant Difference	
Difficulty (M=3.21)	Tukey a=20.87 d=4.26		

Table 13. Tukey pairwise significance test results (Tukey a) and effect sizes (d) for second-year OT student data; all p values < .05 adjusted to .025 unless otherwise noted.

Gender, Academic Year and Previous Experience with Statistics

A separate split-plot analysis was performed on the data obtained from students in the medical program using the attitude factor as the within-subjects variable, along with gender, year and previous statistics experience (experience) as the between-subjects variables. An adequate distribution of subjects was found among the gender by year by experience interaction cells with the smallest cell containing 12 subjects (second year males with no statistics experience).

No univariate outliers were found in any of the gender by year by experience interaction cells and all univariate distributions featured values for skewness and kurtosis that were within acceptable limits. Four subjects were identified as multivariate outliers and removed from further analysis (Table 14). The final analysis sample is represented in Table 15. Mean scores for males and females on each of the subscales are presented in Figure 1.

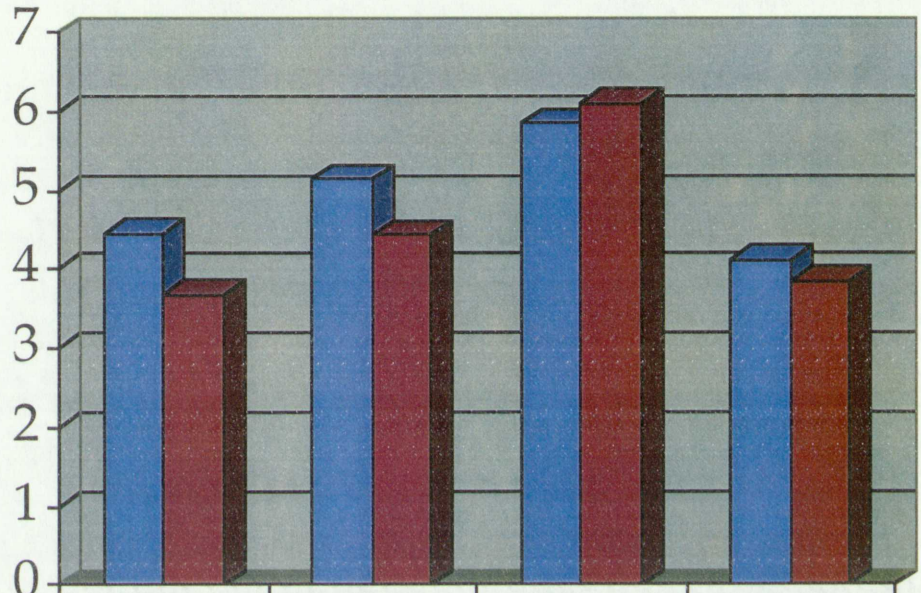
	Gender	Year	Experience	Affect (M)	CC (M)	Value (M)	Difficulty (M)
1.	F	1	No	**1.9+**	**5.0**	**6.6**	**4.3**
				(3.6)	(4.5)	(5.8)	(3.6)
2.	F	1	Yes	**2.9**	**2.7+**	**6.8**	**4.6**
				(3.9)	(4.8)	(6.4)	(3.9)
3.	M	1	Yes	**3.0**	**5.7+**	**5.8**	**3.0**
				(5.1)	(5.5)	(6.2)	(4.4)
4.	F	1	Yes	**3.7**	**4.9**	**7.0**	**6.1+**
				(3.9)	(4.8)	(6.4)	(3.9)

Table 14. Multivariate outliers (marked with a +) and their gender by year by experience cell means.

	Affect SD	Cognitive Competence SD	Value SD	Difficulty SD	n
Females					
Experience					
First Year	**3.94**	**4.82**	**6.38**	**3.90**	**17**
	1.24	1.27	.54	.69	
Second Year	**3.34**	**4.08**	**6.09**	**3.78**	**16**
	1.09	.78	.56	.85	
No Experience					
First Year	**3.64**	**4.51**	**5.77**	**3.63**	**15**
	1.24	.60	.76	.66	
Second Year	**3.74**	**4.32**	**6.19**	**4.04**	**21**
	.88	.82	.59	.69	
Males					
Experience					
First Year	**5.09**	**5.52**	**6.20**	**4.38**	**13**
	.76	.72	.63	.47	
Second Year	**4.24**	**5.02**	**5.73**	**4.00**	**12**
No Experience					
First Year	**4.43**	**5.21**	**5.87**	**4.23**	**14**
	.85	.66	.72	.68	
Second Year	**4.03**	**4.79**	**5.62**	**3.80**	**12**
	1.13	.86	.73	.49	

Table 15. Subscale means and standard deviations by gender and experience for medical students.

Figure 1. Unweighted mean subscale scores by gender.



	AFF	CC	VAL	DIFF
Males	4.45	5.14	5.85	4.10
Females	3.67	4.43	6.10	3.84

As with the previous analyses, Mauchly's test of sphericity was found to be significant ($p<.0005$). Therefore, the Greenhouse-Geisser Epsilon adjustment to the degrees of freedom was used. The Box's M test for homogeneity of dispersion matrices was not significant and the univariate assumption of homogeneity of variance was not violated on any of the subscales.

Table 16 shows that there was a statistically significant interaction between gender and attitude. Simple effects analysis demonstrated that attitude type was significantly related to attitude scores for both females and males.

Source	Partial η^2	SS	df	MS	F	p
Between-Subjects Effects:						
Gender	.090	16.26	1	16.26	11.01	.001
@Affect	.133	17.72	1	17.72	17.20	<.0005
Error		115.39	112	1.03		
@ CC	.151	14.35	1	14.35	19.88	<.0005
Error		80.82	112	.72		
@Value	.039	1.82	1	1.82	4.55	.035
Error		44.73	112	.40		
@ Difficulty	.039	2.01	1	2.01	4.52	.036
Error		49.78	112	.44		
Experience	.020	3.25	1	3.25	2.20	.141
Year	.058	10.10	1	10.10	6.84	.010
Gender x Experience	.008	1.32	1	1.32	.90	.346
Gender x Year	.020	3.30	1	3.30	2.23	.138
Experience x Year	.027	4.52	1	4.52	3.06	.083
Gender x Experience x Year	.009	1.45	1	1.45	.98	.324
Error		165.38	112	1.48		

Source	Partial η^2	SS	df	MS	F	p
Within-Subjects Effects:						
Attitude	.706	301.20	3 (2.23)	100.40	269.12	<.0005
For Females	.668	252.03	3 (2.23)	84.01	225.19	<.0005
For Males	.423	91.89	3 (2.23)	30.63	82.10	<.0005
Error		125.35	336 (250.04)	.37		
Gender x Attitude	.135	19.63	3 (2.23)	6.54	17.54	<.0005
Experience x Attitude	.003	.38	3 (2.23)	.13	.34	.737
Year x Attitude	.022	2.78	3 (2.23)	.93	2.49	.079
Gender x Experience x Attitude	.008	.98	3 (2.23)	.33	.88	.427
Gender x Year x Attitude	.010	1.25	3 (2.23)	.42	1.11	.335
Experience x Year x Attitude	.004	.51	3 (2.23)	.17	.46	.655
Gender x Experience x Year x Attitude	.001	.09	3 (2.23)	.04	.08	.937
Error		125.35	336 (250.04)	.37		

Table16. Source Table for medical student data with gender, experience, year and attitude. (Adjusted degrees of freedom are depicted in parentheses.)

As was seen in previous analyses, post-hoc tests for both males and females showed significantly more positive attitudes regarding the value of statistics than all other attitude dimensions. Attitudes toward the students'

cognitive competence were also significantly more positive than those for affect and the difficulty of statistics as a subject. Once again, these effect sizes were large. No differences were found between mean affect and difficulty scores. Tables 17 and 18 present the results of the post-hoc pairwise comparisons for female and male medical students.

	Value (M=6.10)	**Difficulty** (M=3.84)	**Affect** (M=3.67)
Cognitive Competence (M=4.43)	Tukey a=22.89 d=2.75	Tukey a=8.15 d=.98	Tukey a=10.51 d=1.26
Affect (M=3.67)	Tukey a=33.40 d=4.01	No Significant Difference	
Difficulty (M=3.84)	Tukey a=31.04 d=3.73		

Table 17. Tukey pairwise significance test results (Tukey a) and effect sizes (d) for female Medical student data; all p values < .05 adjusted to .025 unless otherwise noted.

	Value (M=5.85)	**Difficulty** (M=4.10)	**Affect** (M=4.45)
Cognitive Competence (M=5.14)	Tukey a=8.45 d=1.18	Tukey a=12.18 d=1.70	Tukey a=8.11 d=1.13
Affect (M=4.45)	Tukey a=16.55 d=2.31	No Significant Difference	
Difficulty (M=4.10)	Tukey a=20.62 d=2.88		

Table 18. Tukey pairwise significance test results (Tukey a) and effect sizes (d) for male Medical student data; all p values < .05 adjusted to .025 unless otherwise noted.

Simple effects analyses also revealed that gender was related to attitude on two of the four subscales. On the average, males reported significantly more positive attitudes toward their Cognitive Competence (d=.95) and Affect (d=.73) than did the female medical students. There were no gender differences on either the Value or the Difficulty subscales. Where differences were found, effect sizes were moderate to large.

As was seen previously in the analysis of the medical students using only year as the between-subjects factor, a positive main effect for year was found. On average, first year medical students expressed more positive overall attitudes toward statistics than did second year students (d = .21).

As main effects, both gender and attitude type were strongly related to attitude score. However, these should not be interpreted as main effects since they were involved in a statistically significant interaction. The main effects of experience and all other interactions of gender, year, experience and attitude were not statistically significant.

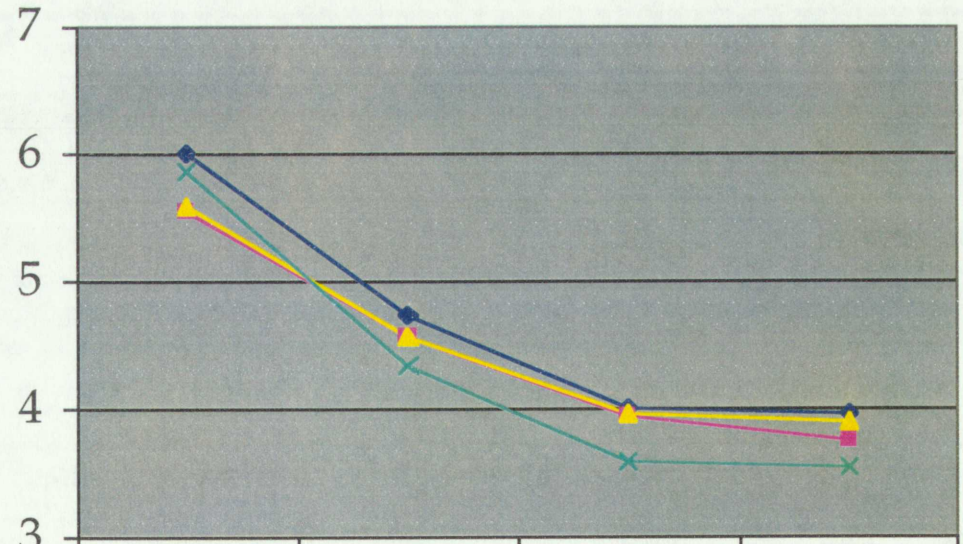
Summary

Data obtained from the UNM Health Sciences students were analyzed in two steps. First, surveys from students in each of the four programs were analyzed separately using attitude as the within-subjects variable and academic year as the between-subjects variable. The search for both univariate and multivariate outliers yielded seven students who were eliminated from the analysis leaving a total sample of 265 subjects. Values for skewness and kurtosis

and the total number of subjects in each cell were considered to be acceptable for the analysis. The reliability of the measure and its subscale scores was acceptable, as evidenced by coefficient alphas that ranged from .64 to .95.

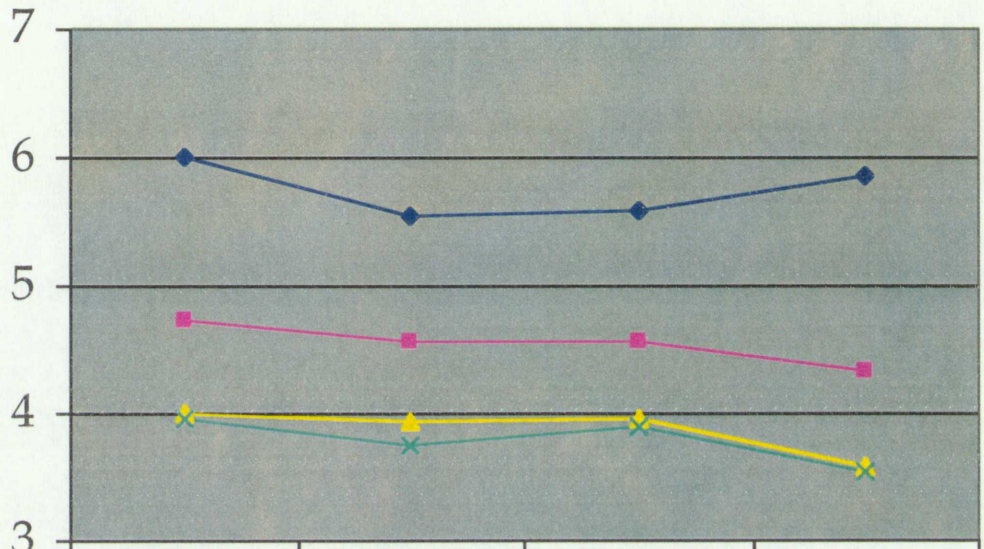
As shown in Figures 2 and 3, a consistent pattern of attitudes emerged as the data were analyzed. Students in all four programs expressed mean attitudes that were more positive regarding the value of statistics than their cognitive competence, their feelings about statistics (Affect) or the difficulty of statistics as a subject. Except for the first year OT students, all groups also demonstrated mean scores that were higher for Cognitive Competence than for both Affect and Difficulty. Mean scores for Affect and Difficulty never differed.

Figure 2. Mean program scores by attitude subscale.



	Value	CC	Affect	Diff
Medical	6.01	4.73	3.99	3.96
Nursing	5.55	4.57	3.94	3.76
PT	5.59	4.57	3.96	3.89
OT	5.86	4.34	3.59	3.55

Figure 2. Mean subscale scores by program.



	Medical	Nursing	PT	OT
Value	6.01	5.55	5.59	5.86
CC	4.73	4.57	4.57	4.34
Affect	3.99	3.94	3.96	3.59
Diff	3.96	3.76	3.89	3.55

The second step in this study involved only the medical student data and was performed to explore possible relationships between attitude toward statistics, gender, academic year and previous statistics experience. While no relationship was found between experience with statistics and attitude, differences were found between males and females on two of the four attitude subscales. Males showed more positive attitudes on the Cognitive Competence and Affect subscales. There were no gender differences in attitudes toward the Value or Difficulty of statistics. In both cases where statistical significance for mean attitude differences was found, the effect sizes were moderate to large.

Chapter 5

DISCUSSION

This chapter includes a summary of the project as well as a discussion of the findings as they relate to the research questions. Suggestions are made regarding the potential use of this information in future curriculum planning in addition to future research in this area. Specific study limitations and their implications are also presented.

Summary of the Study

The ability to effectively and critically review medical literature is a fundamental skill for both students and professionals in the health sciences. A requisite element of productive literature review is the ability to understand the statistical information presented in research articles in order to assess the merits of the study. Most students in the health sciences are exposed to introductory statistics in undergraduate, pre-professional courses. Nearly all such programs also include at least a basic unit on statistical design and analysis in their core curricula. This study is an attempt to identify the attitudes of health science students toward statistics and whether there are attitudinal patterns which are different between first and second year students in each of the four programs investigated.

The Survey of Attitudes Toward Statistics (Schau, et al., 1995) is an instrument which measures four dimensions of attitudes toward statistics: Affect, Cognitive Competence, Value and Difficulty. Scores from its four subscales are

internally consistent; the internal structure of its four subscales has been validated for white undergraduates by confirmatory factor analysis. The ATSMR is a version of the SATS which was modified to reflect attitudes of health sciences students when considering the use of statistics in medical research.

An adequately-sized sample of students was recruited to participate in the study, including approximately 50 students from the Nursing, Occupational Therapy and Physical Therapy programs along with 124 medical students. Female students outnumbered males nearly three to one. All students from the Nursing, OT and PT groups had previously taken introductory statistics while approximately half of the medical students had not. It was not the intent of this study to provide statistical comparisons of the programs to each other; rather, the goal was to obtain useful insights that can be shared with the individual faculty members who are involved in statistics education relative to their respective student populations.

Research Questions

Question 1. Is the ATSMR a reliable measurement tool?

Given the data obtained in this study, the ATSMR appears to be a reliable measurement tool. Coefficient alpha values for the scores from each subscale were calculated on the total survey sample as well as for each program, individually. While there are no specific guidelines, coefficient alphas of greater than .6 or .7 are generally considered to be indicative of acceptable internal consistency. Alpha values for this study ranged from .88 to .92 for Affect, from

.78 to .87 for Cognitive Competence, from .72 to .89 for Value and from .64 to .80 for Difficulty. Furthermore, no single item on the survey would have raised the alpha appreciably if removed. Therefore, all items were retained for the analysis.

Question 2. Are there differences in attitudes toward statistics regarding Affect, Cognitive Competence, Difficulty and Value for students in each of the four programs?

All of the programs exhibited a similar pattern of attitudes in regard to the four dimensions investigated. On average, students in all four programs expressed significantly more positive attitudes relative to the value of statistics compared to the other three dimensions tested. With the exception of the first year OT students, all groups on average also showed significantly more positive attitudes toward their cognitive competence than their feelings toward statistics (Affect) or the difficulty of statistics as a subject. This "I can do it, and I know it's important - but I don't have to like it" attitude seems to be pervasive among the health sciences students.

It is important to recognize, however, that although for all four programs the mean scores for both Affect and Difficulty were negative (that is, below the median option of "4" on a seven-point Likert scale), they were not extremely so. The lowest mean scores on the Affect and Difficulty subscales were 3.57 and 3.53, respectively, while all of the mean scores on the Cognitive Competence and Value subscales were above 4.0. An optimist would conclude from this evidence that these students are not far from having positive attitudes in all areas, and that with the proper guidance such a scenario is achievable.

As a general rule, students in the health sciences are academically strong. This explains why their scores on the Cognitive Competence scale are relatively high. However, the fact that they regard statistics as being difficult suggests a perceived lack of aptitude for math. Hence, it is conceivable that students in the health sciences attribute their statistical abilities to effort rather than to natural ability.

The most remarkable result of this study is the irrefutable evidence that health sciences students value the role that statistics plays in medical research. In light of the fact that their feelings toward statistics (Affect) are neutral at best, this finding speaks to the general level of maturity of these students.

According to the Reinforcement Theory of Hovland, Janis and Kelley (1953), a possible explanation for the relatively positive attitudes of students in the health sciences is that they are being exposed to statistical results in a manner that fosters respect for their merit. In addition, the students may be adopting positive attitudes in order to obtain approval from their peers and the faculty who they perceive as experts in their chosen fields.

Results from the survey strongly illustrate that these students possess an extremely high regard for the value of statistics. Since all four dimensions of attitude that were measured exist within the same conceptual arena, one might conclude that in order to achieve and maintain balance in overall attitude toward statistics, somewhat negative feelings (Affect) about statistics and its difficulty as a subject may be drawn in a positive direction by such strong feelings about its value. Indeed, it may be that educators deploy the tactic of teaching to the value of statistics in order to influence other dimensions of attitude.

Nonetheless, with relatively positive attitudes regarding the value of statistics and their own cognitive competence in coexistence with neutral or negative feelings in the realms of affect and difficulty, some degree of dissonance appears to exist. According to Cognitive Dissonance Theory (Festinger, 1957), this relationship between cognitive elements must be rationalized. In the case of students in the health sciences, resolution may be achieved by the realistic expectation that true statisticians will be called upon to perform the actual statistical analyses for any future research in which they may be involved. The credo, "I'll leave that to the statisticians" is pervasive among health care workers and students, alike.

One disturbing result of this study is the apparent ambivalence that these students demonstrate toward statistics in the realm of affect. If the assertion of Fishbein and Ajzen (1975) that the affective dimension is the most essential, consistent, stable and reliable measure of attitude is correct, it appears that efforts should be made to make students more comfortable with statistics in general. Zeidner's (1991) claim that anxiety is the most powerful affective element suggests that, in order to improve the affective dimension of attitude, the primary goal for educators should be to help students become more at ease with statistics.

Question 3. Is there a difference in overall attitude toward statistics between first and second year students in each of the four health sciences programs?

Differences in overall attitude were found between first and second year students in the medical student sample only. In general, first year medical

students expressed more positive attitudes across all dimensions when compared to second year students. Of course, comparisons across year within programs must be made with caution because two separate groups of students were surveyed. Clearly, a more meaningful comparison would involve a longitudinal design to identify differences over time within the same group of students. Nonetheless, the fact that the other three programs showed no overall differences between the first and second year classes demonstrates remarkable consistency.

Question 4. Are the attitude profiles different for first and second year students in each program?

Further evidence of the relative homogeneity of attitudes among health sciences students is the fact that the interaction between attitude and year was significant only for the OT program. While the same basic pattern of attitudes identified for the three other programs was exhibited by the OT students, second year students had a significantly more negative attitude regarding the difficulty of statistics than their first year counterparts. Again, this must be interpreted with discretion as it reflects the attitudes of two separate groups.

Question 5. Are the attitude profiles different for medical students who have taken an undergraduate statistics course than for those who have not?

Based on the data obtained from the medical student sample, prior experience in undergraduate statistics courses was not related to these students' attitudes toward statistics. The most reasonable explanation for the fact that no

differences were found based on prior experience is that students in the health sciences may have viewed their training in statistics as necessary while at the same time they were successful in the course, academically. The average grade in undergraduate statistics courses reported by these students was an A-. This explains why these students may not have developed negative attitudes toward statistics from their undergraduate experience. Perhaps educators in undergraduate statistics courses need to focus more on students' attitudes in order to foster a more positive view of the subject. It is likely, however, that these students are most heavily influenced by the teachings of their medical faculty and their attitudes are reflective of their exposure to statistics in the medical context. Hence, their undergraduate experience with statistics may be less influential toward their attitudes.

Question 6. Are the attitude profiles different for males and females in the medical program?

Although few previous studies have shown a relationship between gender and attitude toward statistics, this study has. Perhaps these differences were found because the instrument used is more sensitive to gender differences than others. On average, males expressed more positive attitudes regarding their cognitive competence and affect than did females. This finding is consistent with that of Roberts and Saxe (1982) who found more positive overall attitudes among male students. There were no differences in attitudes toward either the value or the difficulty of statistics based on gender.

Application to the Classroom

This study suggests that students in the health sciences at UNM are being exposed to statistics in a manner which reinforces positive attitudes regarding its value. Educators should be commended for their efforts in this area. It is understandable that scores for Cognitive Competence among this population are relatively high because these are academically good students and they have experienced success and rewards for their academic performance. Greater exposure to the actual "anatomy" of statistics may appeal to these students if it is presented in a manner that does not involve assessment of knowledge by formal testing. It is possible that, despite these students' perceptions of high Cognitive Competence, anxiety plays a role in their negative feelings about statistics. The best way to provoke anxiety in students is to impose a test on them.

Feelings toward statistics may also be improved by exposing the students to clinicians who are able to model positive attitudes in this realm. Students have an extremely high regard for clinicians and with their mentorship, statistics may not seem like a mere academic exercise. Discussions of statistical results should be woven into the fabric of each curriculum rather than being set aside in stand-alone courses. Problem-based learning provides an excellent opportunity for impromptu discussions of statistical results in research articles which should be modeled by the facilitators. Journal clubs can also provide an ideal arena in which participants can discuss statistical results without the "threat" of a faculty member present. In short, feelings may change if students witness first-hand that statistics is not merely of interest to educators and clinical researchers.

It is the author's belief that negative attitudes toward the difficulty of statistics are neither unrealistic nor detrimental. Considering the student population in question, improving attitudes in this area may not be a worthwhile goal. Students do not elect to pursue a career in the health sciences because of their strong aptitude for math. Indeed, a healthy respect for the complexity of statistics is quite reasonable. The only way to improve this dimension of attitude would be to have the students perform numerous statistical calculations. Given the volume and importance of the clinical skills and concepts that are featured in compulsory medical education today, the actual ability to perform statistical analyses seems somewhat secondary.

Limitations of the Study

While this study clearly identified commonalties in attitude structure among health sciences students, it remains limited in its scope due to the fact that comparisons are not made over time. A longitudinal study would allow educators to gain insight into their effect on students' attitudes toward statistics. Although some degree of temporal stability can be anticipated, small trends may emerge which could enlighten educators and provide the impetus for adoption of alternative teaching methods.

Another limitation to the study involved recruitment of nursing students. Nearly every first and second year student in the Medical, OT and PT programs was surveyed, but the sample of nursing students relative to the size of the nursing program was somewhat small. This problem occurred because, unlike the other programs, nursing education is not based on a fixed curriculum.

Students take different courses at different times. Due to the timing of the survey, it was difficult to find a representative sample of first year students who had not yet taken their nursing research methodology course. Furthermore, the second year students surveyed who had completed the nursing program's research course was not randomly selected. Hence, the data obtained from the nursing students may be contaminated by suboptimal selection methods and a relatively small sample.

A final limitation relates to the fact that this survey was only distributed to students at the University of New Mexico. Because only UNM students were included, the scope of this study is limited and generalization of its results to the health science student population as a whole is inappropriate.

Recommendations for Future Research

Since this study has clearly provided a stable and reliable tool for measuring attitudes toward statistics, the next step should be to validate the internal structure of the ATSMR using confirmatory factor analysis. As previously mentioned, ongoing collection of data will provide an opportunity to observe changes in attitude over time. Furthermore, it would be fascinating to use the ATSMR in conjunction with measures of connected understanding of statistics concepts as well as motivation in order to gain deeper insight into the psychosocial and intellectual infrastructure of today's health science students. Research could be conducted using the ATSMR comparing attitudes of students to those of clinicians or students in non-health-related programs. Finally, this study in its present form could be expanded to include health sciences programs

across the country in order to identify institutional or regional differences in attitudes toward statistics.

APPENDICES

Appendix A

Survey of Attitudes Toward Statistics in Medical Research

DIRECTIONS: The questions below are designed to identify your attitudes about the use of statistics in the research studies you read. The item scale has 7 possible responses; the responses range from 1 (strongly disagree) through 4 (neither disagree nor agree) to 7 (strongly agree). Please read each question. From the 7 point scale, carefully mark the one response that most clearly represents your agreement with that statement. Use the entire 7-point scale to indicate your degree of agreement or disagreement with the items. Try not to think too deeply about each response. Record your answer and move quickly to the next item.

	STRONGLY DISAGREE			NEITHER DISAGREE NOR AGREE			STRONGLY AGREE
1. I like statistics.	1	2	3	4	5	6	7
2. I have no trouble interpreting statistical information in health science journals.	1	2	3	4	5	6	7
3. Learning to interpret statistical information requires a great deal of discipline.	1	2	3	4	5	6	7
4. I have difficulty understanding statistical results because of how I think.	1	2	3	4	5	6	7
5. The statistical information in the studies I read is not that important.	1	2	3	4	5	6	7
6. Statistics are a necessary part of quantitative medical research.	1	2	3	4	5	6	7
7. Interpreting statistical results in journals should be a required part of my professional training.	1	2	3	4	5	6	7
8. Understanding statistical concepts will make me more successful as a clinician.	1	2	3	4	5	6	7
9. Statistics doesn't make sense to me.	1	2	3	4	5	6	7
10. Statistics is not useful for most health care professionals.	1	2	3	4	5	6	7
11. I get frustrated when I read statistical results in medical journals.	1	2	3	4	5	6	7
12. Statistical thinking will not be necessary in my professional life.	1	2	3	4	5	6	7

Appendix A (Continued)

	STRONGLY DISAGREE			NEITHER DISAGREE NOR AGREE			STRONGLY AGREE
13. Statistics doesn't scare me at all.	1	2	3	4	5	6	7
14. Statistical analysis of clinical data has been an important factor in the evolution of modern health care.	1	2	3	4	5	6	7
15. I have no difficulty understanding the statistical results in the studies I read.	1	2	3	4	5	6	7
16. I enjoy reading statistical results in health science journals.	1	2	3	4	5	6	7
17. The statistical results in health science journals are easy to understand.	1	2	3	4	5	6	7
18. Most people can learn to interpret statistical results quickly.	1	2	3	4	5	6	7
19. As a professional, I will have no use for statistics.	1	2	3	4	5	6	7
20. There is too much math in statistics for me to understand it.	1	2	3	4	5	6	7
21. I feel intimidated by the statistical information I read in journal articles.	1	2	3	4	5	6	7
22. Statistics involves massive computations.	1	2	3	4	5	6	7
23. If I apply myself, I can understand the statistical results I read in journals.	1	2	3	4	5	6	7
24. Statistical results are highly technical.	1	2	3	4	5	6	7
25. I find it easy to understand statistics concepts.	1	2	3	4	5	6	7
26. Most people have a hard time understanding the statistical information presented in health science journals.	1	2	3	4	5	6	7
27. I dread having to read statistical results in journals.	1	2	3	4	5	6	7
28. I feel self-confident when reading statistical information in journals.	1	2	3	4	5	6	7

Appendix A (Continued)

	STRONGLY DISAGREE			NEITHER DISAGREE NOR AGREE			STRONGLY AGREE
29. Trying to understand statistical information in journals is stimulating to me.	1	2	3	4	5	6	7
30. Statistical analyses are extremely complicated.	1	2	3	4	5	6	7
31. Reading statistical results in journals makes me feel uncomfortable.	1	2	3	4	5	6	7
32. One would have to be a statistician to really understand the statistical information in most medical journals.	1	2	3	4	5	6	7

Appendix B

Questions By Subscale

AFFECT

1. I like statistics. (+)
11. I get frustrated when I read statistical results in medical journals. (-)
13. Statistics doesn't scare me at all. (+)
16. I enjoy reading statistical results in health science journals. (+)
21. I feel intimidated by the statistical information I read in journal articles. (-)
27. I dread having to read statistical results in journals. (-)
28. I feel self-confident when reading statistical information in journals. (+)
29. Trying to understand statistical information in journals is stimulating to me. (+)
31. Reading statistical results in journals makes me feel uncomfortable. (-)

COGNITIVE COMPETENCE

2. I have no trouble with interpreting statistical information in health science journals. (+)
4. I have difficulty understanding statistical results because of how I think. (-)
9. Statistics doesn't make sense to me. (-)
15. I have no difficulty understanding the statistical results in the studies I read. (+)
20. There is too much math in statistics for me to understand it. (-)
23. If I apply myself, I can understand the statistical results I read in journals. (+)
25. I find it easy to understand statistics concepts. (+)

VALUE

5. The statistical information in the studies I read is not that important. (-)
6. Statistics are a necessary part of quantitative medical research. (+)
7. Interpreting statistical results in journals should be a required part of my professional training. (+)
8. Understanding statistical concepts will make me more successful as a clinician. (+)
10. Statistics is not useful for most health care professionals. (-)
12. Statistical thinking will not be necessary in my professional life. (-)
14. Statistical analysis of clinical data has been an important factor in the evolution of modern health care. (+)
19. As a professional, I will have no use for statistics. (-)

DIFFICULTY

3. Learning to interpret statistical information requires a great deal of discipline. (-)
17. The statistical results in health science journals are easy to understand. (+)
18. Most people can learn to interpret statistical results quickly. (+)
22. Statistics involves massive computations. (-)
24. Statistical results are highly technical. (-)
26. Most people have a hard time understanding the statistical information presented in health science journals. (-)
30. Statistical analyses are extremely complicated. (-)
32. One would have to be a statistician to really understand the statistical information in most medical journals. (-)

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