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Connecting Art and Science: An Interdisciplinary Strategy and its Impact on the Affective Domain of Community College Human Anatomy Students

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CONNECTING ART AND SCIENCE: AN INTERDISCIPLINARY STRATEGY AND ITS IMPACT ON THE AFFECTIVE DOMAIN OF COMMUNITY COLLEGE HUMAN ANATOMY STUDENTS

by

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ABSTRACT

Educational objectives are often described within the framework of a three-domain taxonomy: cognitive, affective and psychomotor. While most of the research on educational objectives has focused on the cognitive domain, the research that has been conducted on the affective domain, which speaks to emotions, attitudes, and values, has identified a number of positive outcomes. One approach to enhancing the affective domain is that of interdisciplinary education.

Science education research in the realm of interdisciplinary education and affective outcomes is limited; especially research conducted on community college students of human anatomy. This project investigated the relationship between an interdisciplinary teaching strategy and the affective domain in science education by utilizing an interdisciplinary lecture in a human anatomy class. Subjects were anatomy students in a California community college who listened to a one-hour lecture describing the cultural, historical and scientific significance of selected pieces of art depicting human dissection in European medieval and Renaissance universities. The focus was on how these renderings represent the state of anatomy education during their respective eras.

After listening to the lecture, subjects were administered a 35-question survey that was composed of 14 demographic questions and 21 Likert-style statements that asked respondents to rate the extent to which the intervention influenced their affective domain. Descriptive statistics were then used to determine which component of the affective domain was most influenced, and multiple regression analysis was used to examine the extent to which individual differences along the affective continuum were explained by select demographic measures such as gender, race/ethnicity, education level, and

previous exposure to science courses. Results indicate that the interdisciplinary intervention had a positive impact on every component of the affective domain hierarchy, and gender and Latino ethnicity seem to be the best predictors of affective outcomes.

Since the results of this research suggest that student thinking can be modified beyond cognitive content, science educators now have access to an interdisciplinary approach to affective outcomes that is both grounded in the literature and empirically tested. Future students may now be more likely to be exposed to a teaching methodology that is quite possibly deeper and richer.

DEDICATION

This doctoral dissertation is dedicated to the single most important component of my life. My family.

To my beautiful and faithful wife Coreen, you are the bedrock of our family. You are my companion, confidant, and best friend. After 20 years together, I still feel as if we were just married. If I had the opportunity to do it all over again, I would.

To my children, I love you both more than life itself. Olivia, you are my first-born and only daughter. You changed everything when you came along. You have a combination of self-confidence, intelligence, and ironic wit that is rivaled only by your beauty (both inside and out). To Dominic, my only son, and my little buddy, you will always be my baby. You are the brightest, sweetest and most fun loving creature that the good Lord ever put on this earth.

I love you all and am so grateful for your support when I was at USD.

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I would like to thank the administration and faculty at San Diego Miramar College for allowing this study to be conducted on its campus. I especially would like to acknowledge the cooperation of vice president of instruction, Pam Deegan, and the dean of business, math and science, Mary Benard. Without administrative approval, this project would have never taken place. I am also very grateful to my colleagues in the department of natural sciences who allowed me to collect data in their anatomy classes. Dr. Dan Trubovitz and Dr. Marie McMahon have been particularly encouraging of my views concerning the nexus between art and science. Many thanks to them also for agreeing to the placement of numerous Renaissance anatomical illustrations throughout our lab!

If it were not for the incredible patience, support and guidance from the members of my dissertation committee, this handsome volume would never have materialized. First, I would like to thank Dr. Iris Engstrand. Without question, she is one of the most well respected professors in the University of San Diego community. Not only did I rely on her expertise as an historian and her capacity as an academician, but I also am most grateful for her friendship during this process.

Dr. Sandy Buczynski was also instrumental in this project, and I am very thankful to her as well. I admire her talent as a science educator, but more importantly, I am indebted to her for introducing me to the concept of affective objectives. When I first came to her with an approximate idea of the kind of research I wanted to pursue, she assisted me by packaging my thoughts into an achievable dissertation.

Lastly, I would like to acknowledge my academic advisor, professional mentor, and good friend, Dr. Fred Galloway. He was patient with me above and beyond the call of duty. He promptly responded to my every question, quickly returned drafts, and offered directions of exploration that I had not previously considered. More impressively, he has a command of research methods and statistical analysis that is unparalleled. I am humbled by his abilities.

I would also like to thank the many professors who instructed me during my doctoral studies. I became acquainted with a diversity of faculty because I pursued a program of study in the school of leadership and education sciences, and the school of nursing and health science. The resulting combination of courses in leadership, education, and health science is emblematic of interdisciplinary education. I am grateful to both of these schools for allowing such a course of study.

This page would be incomplete if I were to not recognize my human anatomy and physiology students. A unique blend of youth, intellectual curiosity, and jocularity resides in each one of them, and I greatly treasure this. I often say that I have found my niche in life by teaching at a community college. I can think of no better vocation than teaching a discipline for which I am truly passionate to an audience whose company I sincerely enjoy. I can honestly say that I look forward to going to work every day.

I firmly believe that the concepts behind this project have benefited my students. I trust that they now appreciate that human form and function is more than just science, but elegance as well. It is also my hope that this dissertation will inspire my colleagues to adopt an enhanced model for teaching. Interdisciplinary education, I contend, is beneficial not only in the anatomic sciences, but throughout higher education.

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INTRODUCTION

Why This Topic?

In the spring of 1994, I attended the 8th Annual Conference of the Human Anatomy and Physiology Society that was held in Portsmouth, New Hampshire. At that time I had only been teaching human anatomy and physiology for a few semesters at San Diego Miramar College. This was my first professional conference of the discipline.

It was a seminar delivered by Dr. K. B. Roberts, history of medicine professor emeritus at Memorial University in St. John's Newfoundland, that introduced me to the idea of connecting art and anatomy. I vividly remember being spellbound by the European medieval and Renaissance anatomical images that he presented. I had an epiphany. If I was enthralled with these images, could the same be said for my students? Could these images be used in my anatomy and physiology classes to somehow enhance the lecture environment by providing a deeper and richer experience?

In the following years, I began to introduce similar images that I had researched into my lectures. I went beyond the Eurocentric focus of Dr. Roberts' presentation and included images from India, China, Japan, and beyond. As I presented each image, I discussed its scientific, cultural, and historical relevance. The response from students was overwhelming. They too found these renderings fascinating. From my observations, beginning a class with a lecture about a relevant, historical anatomical image seemed to grab the students' attention in a unique way. Intuitively, I knew this was a valuable endeavor.

Some of my colleagues learned of my interdisciplinary approach; a method of incorporating artistic, cultural, and historical vignettes into my anatomy and physiology classes. Consequently, I was invited to speak about this at several conferences of the Human

Anatomy and Physiology Society, and the National Association of Biology Teachers. I was also approached by a publisher to be a contributing author to an anatomy text: *Principles of Human Anatomy*, by Tortora (2002). For each of the 28 chapters in the book, I selected an image, and wrote an essay. These essays were tied to the chapter, and included thought provoking questions. As I wrote in the preface, the images and essays were intended to help students:

> Gain insight into the historical saga of anatomical studies, view images that reflect the evolution of the scientific method, and understand that the current body of anatomical knowledge is by contributions from the whole world. With visually beautiful images from Africa, Malaysia, Europe, and Japan, students are likely to "see themselves" and perhaps be more excited about their studies. (p. IV)

By the time the Tortora (2002) text was published, I was a doctoral student at the University of San Diego. I knew that this teaching technique must be the basis for my dissertation. I parlayed my work on the Tortora text into my qualifying paper, and counseled with my advisors as to how I could develop my ideas into a dissertation. It was during a consultation with Dr. Sandy Buczynski that the concept of affective educational objectives was broached. All of the pieces were finally in place. I could now ground my educational approach in pedagogical theory.

In the following chapters of this dissertation, the theoretical underpinnings of interdisciplinary education are presented. The methodology of how I quantitatively measured the impact of this technique on students is outlined. And the results from this empirical exercise are presented and discussed. It is my hope that this dissertation will contribute to the body of literature which contends that interdisciplinary education is a valid and valuable

method of teaching. It is my firm belief that students enjoy and benefit from such an approach. It is my dream that interdisciplinary education will become more than a novelty, but the paradigm.

CHAPTER 1: OVERVIEW OF THE STUDY

Introduction

Educational Objectives: A Background

In the midpoint of the previous century, the seminal work supporting the modern underpinnings of curriculum writing and student assessment was published. This piece resulted in the development of a classification scheme meant to "clarify and tighten the language of educational objectives" (Krathwohl, Bloom & Masia, 1964, p. 4). The publication *Taxonomy of Educational Objectives: The Classification of Educational Objectives: Handbook I: Cognitive Domain* (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956), functioned as the contemporary framework for teachers, administrators and researchers in curriculum affairs. *Bloom's Taxonomy*, as it is commonly referred to today, serves to give direction to the learning process in a variety of ways.

The authors conceded that use of the term taxonomy, which is often considered a biological term for classifying organisms, resulted in criticism. They write: "critics suggested that many of our readers would not understand what taxonomy meant and that the word would produce more confusion than was desirable. In any case, we have retained the term taxonomy" (Krathwohl et al., 1964, p. 11). By developing this taxonomy, or classification system of educational objectives, the terminology of such objectives can be considered more meaningful by virtue of a clearly defined vocabulary. Ambiguity of terms is less likely as curriculum authors and readers of educational objectives are more likely to be speaking the same professional language. The evaluation process is also enhanced by virtue of this taxonomy providing structure to the process of ordering and describing test items, examination techniques, and evaluation instruments. Also, researchers can be assisted in

comparing and studying various educational programs if their educational objectives were developed with a common taxonomy. Finally, and perhaps most ambitiously, the taxonomy goes beyond a classification scheme and attempts to provide future researchers the ability to develop learning theories from educational programs and approaches that are based upon this taxonomy (Krathwohl et al., 1964).

Bloom's Taxonomy divides objectives into three major domains: cognitive, affective, and psychomotor (Bloom et al., 1956). The cognitive domain, which is the primary focus of the book, addresses objectives concerning "recall or recognition of knowledge and the development of intellectual abilities and skills" (Bloom et al., 1956, p.7). The affective domain addresses "changes in interest, attitudes, and values" (Bloom et al., 1956, p. 7), as well as internal shifts that influence an individual's "philosophy of life or world view" (Krathwohl et al., 1964, p. 165). The final domain identified is the psychomotor domain that focuses on manipulative, motor skill, or neuromuscular educational objectives. These objectives are related to such programs as handwriting, speech, physical education, and trade and technical courses (Krathwohl et al., 1964).

This taxonomy developed to be one of the most widely cited monographs in American education (Anderson & Sosniak, 1994). Since its introduction almost 50 years ago, this small volume has become a reference text for college and university examiners, curriculum planners, administrators, researchers and classroom teachers at all levels of education (Bloom, 1994). Its success can most likely be attributed to a previously unmet need for a structured approach to curriculum planning and student assessment (Bloom, 1994). While *Bloom's Taxonomy* is solely devoted to the cognitive domain, it makes reference to the importance of the other domains, especially the affective.

Attention to the affective domain, spurred on by the success of and produced by a cadre from the original taxonomy, resulted in a companion publication, *Taxonomy of Educational Objectives, The Classification of Educational Objectives, Handbook II: Affective Domain* (Krathwohl et al., 1964). Modeled after the original handbook, the concept of affective objectives was further developed. A unity with the cognitive domain was reinforced, and affective objectives were identified across a broad hierarchy beginning with mere awareness of particular phenomena, and culminating in a modification of a person's philosophical outlook (Krathwohl et al., 1964). This affective domain addresses learning outcomes in the realm of student disposition towards a particular concept. The categories of the affective taxonomy, intended to be hierarchical in order and arranged along a continuum from lowest to highest, is listed in Appendix A.

The development of a taxonomy in relation to affective objectives was certainly embraced by the educational community, however, the cognitive domain was destined to be deemed of greater importance by most educators (Schibeci, 1983). Despite soliciting input from educational workers, Bloom and his colleagues did not publish a third handbook identifying educational objectives relative to the psychomotor domain. The only taxonomy directed at the psychomotor domain identified in the literature is that of Harrow (1972).

The Affective Domain and Science Education

In the realm of science education, affective objectives have been the subject of much investigation. Despite decades of research into this area, however, science teachers – as well as other educators – tend to regard cognitive objectives more important than affective objectives (Iozzi, 1989; LaForgia, 1988; Schibeci, 1981). To be sure, many researchers have echoed the sentiments of Gephart, Ingle and Marshall (1976), "Answering questions about

attitudes, interests, values or feelings is not easy. In the past, educational traditions, technology and practices have reflected a tendency to relegate these questions to a lesser status in comparison to questions concerning cognitive growth and development." (p. 3) Notwithstanding this circumstance, the influence of affective objectives on attitudes towards science and cognitive achievement in science coursework is indeed considered important by many (Schibeci, 1984) and has been researched in a multitude of scientific disciplines.

The somewhat indistinct relationship between the affective domain and cognitive achievement may explain the reluctance among many to greatly value affective objectives (Simpson, 1978). Indeed, increasing cognitive success vis-à-vis affective objectives is a difficult phenomenon to document. Yet the relationship between these domains, a relationship that despite being difficult to quantify and research, is an association that many researchers intuitively agree exits. Krathwohl et al., (1964) writes "The fact that we attempt to analyze the affective area separately from the cognitive is not intended to suggest that there is a fundamental separation. There is none." (p. 45) This notion that the major domains of learning are intertwined is perhaps most elegantly described by Gephart and Ingle (1976), "As a case in point consider the behavior of an artist. Composing and rendering a work of art are prime examples of the inexorable unity of what is called cognitive, affective, and psychomotor behaviors." (p. 186)

As stated earlier, despite affective domain research being considered not particularly important by many and problematic by most, it is still the focus of investigation by myriad educational researchers, including science educators. When considering specific scientific disciplines that have been addressed, a sampling of the literature reveals that research concerning affective objectives in relation to science education include: engineering

(Simpson, 1978), physics (Alsop & Watts, 2000), geology (Ediger, 1999), nursing (Cook and Cullen, 2003; Rinne, 1987), earth science (Johnson, 1976), biology (Simpson & Wasik, 1978) and medical education (Ten Cate & De Haes, 2000).

An exhaustive attempt, however, to identify research in the biological sub-discipline of human anatomy at the undergraduate level has proved problematic. Indeed, the only literature item of this type investigated the use of group art projects as a tool to determine individual student learning style. Price (1995) reported that utilizing interdisciplinary group projects resulted in greater retention of information as well as students being more motivated, creative and interested. This paper supports the notion that there is some merit in pursuing interdisciplinary activities with community college human anatomy students. Further, interdisciplinary teaching also seems to positively influence components of the affective realm Price (1995).

Interdisciplinary Teaching and Science Education

The definition of interdisciplinary teaching is somewhat vague in the literature. While the literature has identified an "Interdisciplinary Continuum" that condenses the research into an understandable framework of disciplinary blending (Adler & Flihan, 1997), the most popular operational definition employed in the literature describes interdisciplinary teaching as an educational theory or practice that combines two or more disciplines (Beck, Copa & Pease, 1991; Drake, 1991; Fogarty, 1991; Jacobs, 1989a; Jacobs, 1989b; Kain, 1993; McIntosh & Meacham; 1992; Nissani, 1995; Petrie, 1992; Tchudi & Lafer, 1996; Vars, 1991; Wood, 1997).

In some ways, interdisciplinary teaching is analogous to affective objectives. There is no widely accepted research supporting its benefit, just as there is difficulty in establishing an

empirical relationship between affective objectives and cognitive achievement. Generally speaking, however, it can be stated that, although interdisciplinary teaching has not been exhaustively investigated with rigorous research, it has long been supported as a pedagogical approach (Adler & Flihan, 1997). The institutional support for this pedagogical approach that many educators enjoy is most likely a result of teachers instinctively believing in its value. Teachers themselves also tend to report increased enthusiasm, interest, and enjoyment (Muncey & McQuillan, 1996). Further, research seems to establish a link between interdisciplinary teaching and both the cognitive and affective domains of students. In referring to student implications, Adler and Flihan (1997) write, "Overall, the literature suggests that participation in an interdisciplinary curriculum is associated with positive changes in achievement, behavior and attitude." (p. 31) While the terms cognitive and affective are not directly stated by Adler and Flihan (1997), it seems that it can safely be discerned that these domains are being referenced in the above quotation.

The dated nature of the aforementioned professional literature, much of it being ten years or older, supports the need for further research in the realm of affective learning outcomes. This is especially true as it relates to interdisciplinary science education and the affective domain of learning.

Statement of the Problem

The brief discussion of the literature above suggests several issues: a significant component of the educational community considers affective objectives a worthy pedagogical enterprise; although science educators have examined affective outcomes with mixed results, there seems to be a positive relationship between affective endeavors and cognitive achievement; affective objectives have been investigated in a cross section of

scientific disciplines, yet human anatomy courses at the community college level have not received much attention; and interdisciplinary techniques seem to have a positive impact on affective measures. With the above issues being supported by the literature, it appears reasonable to conclude that there is value in pursuing an investigation of the influence of interdisciplinary methods on affective outcomes for community college human anatomy students.

Purpose of the Study

The purpose of this study was to investigate the relationship between an interdisciplinary science education strategy and educational objectives. More specifically, this research attempted to connect art and science by examining the relationship between a cultural, historical and artistic presentation in a community college human anatomy class on affective domain learning outcomes of students.

The notion of introducing historical and cultural themes into science education is supported in the literature. Rutherford and Ahlgren (1990) identify that science classes can enjoy great benefits in discussing landmark historic events in relation to the development of Western thought and civilization. Rutherford and Ahlgren (1990) go on to state that there are many significant episodes in the history of science that have had great impact on cultural heritage. Others write that historical modes of thinking in science education also introduce issues such as social and political context, as well as scientific motivations and constraints (Mansilla, Miller & Gardner, 2000).

Research Questions

The above theoretical background and statement of the problem justifies the following two research questions: 1. How will any component of an undergraduate human

anatomy student's affective domain be at all influenced when s/he is exposed to an interdisciplinary lecture that examines selected artistic renderings that explore the historical, cultural, and artistic heritage of human anatomy? 2. Does this influence vary by any one of a number of student demographic variables?

Hypotheses

The following hypotheses are posited in response to the above research questions. 1. If a student is exposed to an interdisciplinary module, its influence is most likely to occur at the lower levels of the affective domain hierarchy due to the brief nature of the intervention. 2. If a student is exposed to an interdisciplinary module and his/her affective domain is positively shifted, the statistically significant demographic variables will be age, educational level and GPA.

Significance of the Study

The significance of this study is threefold. Firstly, science education research in the realm of interdisciplinary education, especially in human anatomy, and affective outcomes is limited. This study has contributed to such literature, and perhaps more significantly, it will engender interdisciplinary human anatomy teaching by other practitioners. Secondly, science educators interested in interdisciplinary education will now have access to a model that is both grounded in the literature as well as empirically tested. As a result, this study has potentially served as a foundation for curriculum development in the arena of art-science interdisciplinary education. Finally, future students may be more likely to be exposed to a teaching methodology that is quite possibly deeper and richer. Students exposed to this kind of teaching are likely to acquire an enhanced aesthetic awareness and appreciation of the nexus between art and science.

Limitations of the Study

A significant limitation of this study is that it employs convenience sampling as opposed to a randomized design for the selection of subjects. Also, this study does not include a control group. Subsequently, generalization of results beyond the research population of San Diego Community College District students is problematic. Additionally, although the sample size of 145 students is substantial, this study, vis-à-vis regression analysis, provides information related to correlation, and does not specifically address causation. Also, the research instrument employed to measure student affective outcomes was developed by the researcher, and subsequently, has not been empirically tested for either validity or reliability. Further research could be conducted in this area so as to buttress the results of this of this study. Finally, this study is cross-sectional and therefore is a "snapshot" of student dispositions following a brief intervention. Subsequent studies should be longitudinal, include interdisciplinary interventions throughout a semester, and include a control group in its design.

CHAPTER 2: REVIEW OF RELATED LITERATURE

Introduction

The principle aim of this project is to investigate the impact of a college human anatomy interdisciplinary module on student affective learning objectives. Subsequently, this literature review has three main foci. The initial component addresses research relevant to science education and affective objectives. This includes studies that measure student attitudes and values consequent to science education, as well as the instruments employed to measure affective outcomes. The following element concentrates on the volume and nature of studies that investigated interdisciplinary methods in science education settings, especially community college and university level anatomy courses. The remaining portion of this review will build the case that this project was justifiable.

Affective Objectives in Science Education

Although it was stated earlier that some researchers do not consider affective objectives particularly important, there is a significant component of the education community that would disagree. Indeed acknowledgment of the importance of affective objectives, especially in science education in particular, is replete in the literature. Choppin and Frankel (1976) write "It is almost universally acknowledged that educational objectives in the affective domain – those dealing with attitudes, interests and values – are of great importance." (p. 57) Schibeci (1984) states, "The science education community, for one, appears to regard the affective domain as important (see, for example, Baker & Doran, 1975). Some crude indicators of this interest are the numbers of papers presented at conferences and dissertations in this area." (p. 26)

The literature identifies several main areas where student attitudes towards science are investigated. These categories include: attitudes towards science (such as science coursework and careers), attitudes towards scientists, and attitudes towards the scientific method (Aiken & Aiken, 1969; LaForgia, 1988; Munby, 1980; Schibeci, 1984). An additional category of scientific attitudes, as defined as open-mindedness, tolerance to the views of others, honesty and skepticism, was identified by Gardner (1975) as well as Schibeci (1984). In toto, these areas are somewhat disparate and represent quite an attitudinal range in students.

In providing a framework for curriculum development, Klopfer (1971) identified a broad array of instructional objectives that he suggests teachers of science courses should encourage their students to express in terms of behaviors. A significant component of these behaviors are in the realm of attitudes and interests. These included all of the attitudes listed above, but also included what may be termed higher-level attitudes and behaviors. These are: adoption of scientific attitudes, enjoyment of science learning experiences, development of interests in science and science-related activities, and development of interest in pursuing a career in science or science-related work. In describing the import of these student attitudes and behaviors in science education, Klopfer (1971) writes:

> No one wishes to see the student affect a fawning awe of science or an uncritical reverence of scientists. Nonetheless, it is reasonable to see whether the student will speak, write, and act in ways which show that he places a positive value on the role of science in furthering man's understanding and that he gives due acknowledgment to scientists for their past and potential future contributions in this quest. (p. 577)

While in this above quote Klopfer (1971) lists a wide range of attitudes, he seems to ground these attitudes, at least partially, in the importance of the history of science.

In an exhaustive science attitudes literature review of over two hundred studies, Schibeci (1984) recognized several categories of problems in the literature. Schibeci (1984) writes, "One problem which plagues attitude research is the lack of theoretical framework." (p. 43) Not distinguishing clearly between knowledge and attitudes seems to be a common fault in many studies. Perhaps some researchers blur the distinction between cognitive and affective objectives. Notwithstanding, Schibeci (1984) goes on to identify other problematic issues including: instruments that measure attitudes are rarely supported with reliability and validity data, specific attitude objects (i.e., attitudes to science, scientific attitudes etc.) are often not clearly identified, more variables that may influence attitudes need to be examined, the long-lasting effects of attitude change is absent of study, subtleties between cognitive achievement and the affective domain must still be sufficiently teased out, and finally, the case has not been adequately made for the inclusion of attitudinal objectives for grading purposes in science curricula.

Schibeci (1984), however, does identify certain demographic variables that seem to genuinely influence student attitudes to science. There seems to be a strong relationship between gender and attitudes to science. The literature consistently identifies males, especially older males, as having more positive attitudes towards science. This is wholly supported by Gardner (1975) who wrote, "Sex is probably the single most important variable related to pupils' attitudes to science" (p. 22). As a general term, however, "science" may be too broad. As indicated by Ormerod and Duckworth (1975) it is important to distinguish

between physical science and biological science. It seems that males are more positive towards the physical sciences than females.

Schibeci (1984) goes on to state that evidence suggests home background and peer group variables are likely to be important, but they may only influence attitudes in an indirect manner. Finally, Schibeci (1984) identifies that an inverse relationship exists between attitudes towards science and higher-grade levels. Whether or not attitudes towards science decline more precipitously than student attitudes towards other disciplines as a student advances in grade is still in question. For example, Choppin, (1974) concluded that as students advance in grade their attitudes towards physics and chemistry declined more rapidly than attitudes towards disciplines such as history and geography. This seems to be an area where further research is warranted.

Beyond gender and grade level, other demographic variables have been examined in relation to student attitudes towards science. Socioeconomic status has been studied with mixed results. Schibeci (1984) reports that there is not a strong relationship between socioeconomic status and science related attitudes. Perhaps most relevant to this study, Schibeci (1984) goes to state that students in Israeli religious schools displayed a greater interest for studying the human body when compared to students from nonreligious schools.

The arena of evaluating the effectiveness of affective objectives in science education has also been the focus of much research. Gephart and Ingle (1976) introduced a theoretical framework grounded in a problem-solving approach that suggests directions for evaluation in the affective domain. LaForgia (1988) laments what he identifies as chaos in this sphere of research by stating, "This situation is unfortunate in view of the fact the area has been conveniently divided and described into two categories, attitudes towards science and

scientific attitudes." (p. 419) Perhaps this chaos is a result of science education affective domain research being more complicated than these two convenient categories. As outlined above, others have clearly identified attitudes to be strewn across a much wider spectrum (Aiken & Aiken, 1969; Gardner, 1975; Klopfer, 1971; Schibeci, 1984). Despite the lack of consensus concerning categorization of attitudes, affective domain evaluation instruments and techniques abound.

In a comprehensive review of affective domain evaluation methods, LaForgia (1988) grouped techniques into several categories: interviews, open-ended questions, closed item questionnaires (i.e., Likert and Thurstone scales), and preference ranking. LaForgia (1988) discussed the pros and cons of each of these techniques, and went on to identify Likert scales as being the most commonly employed techniques because they are the most time effective instruments in classroom situations. This is consistent with other thorough literature reviews of science attitudes research (Munby, 1980). Further, LaForgia (1988) identified Fraser's (1978) Test of Science Related Attitudes (TOSA) as perhaps the most frequently used Likert type scale for the measurement of science related attitudes. It is one of the few instruments successfully tested with rigorous trials to determine validity and reliability (LaForgia, 1988). Another popular Likert type instrument is Moore and Sutman's (1970) Science Attitude Survey (SAI). The SAI, however, did not fare as well in similar tests (Munby, 1983). Further, in an exhaustive review of instruments used to measure affective outcomes in science education, Munby (1980) identified over 200 instruments cited in the literature. He evaluated over 50 of these for reliability and validity and concluded that only seven of these were minimally acceptable. Munby (1980) also noted that the vast majority of these instruments

were used in only one study and were geared toward elementary and secondary school students.

Summary - Affective Objectives in Science Education

A summary of the literature examining the affective domain and science education can be described as follows. Affect seems to be defined by most researchers as attitudes. These attitudes towards science are categorized in a variety of forms. There is an abundance of instruments measuring attitudes and affect present in the literature; however, several researchers confirm that the vast majority of these are deficient as it relates to statistical validity and reliability. Also, most instruments are utilized in only one study and employed in either elementary or secondary school settings.

Interdisciplinary Teaching in Science Education

Educators have championed the concept of teaching in an interdisciplinary manner for decades (Adler & Flihan, 1997). Dewey (1956) describes isolation of subject matter as being "disconnected from the rest of experience so that it is not available under the actual conditions of life" (p. 49). This idea of an interdisciplinary approach to education also seems to support Gardner's (1983) multiple intelligences theory that prescribes departing from traditional pedagogical practices and teaching in a variety of ways, including techniques that would combine two or more disciplines in a single lesson.

An exact definition of interdisciplinary education is difficult to identify in the literature. It seems that this field is theoretically quite broad. Phrases such as the "...study of relationship among disciplines..." (Doebler, 1980, p. 11) and the "areas of educational research, knowledge, or theory that combine two or more disciplines" (Adler & Flihan 1997, p. 5) can be found in literature that attempts to define this approach to teaching.

Notwithstanding the broad definitions, interdisciplinary education seems to be a well-accepted practice. Indeed, a national survey of over 10,000 high schools reported that interdisciplinary teaching was in some form either in use or planned to be in use by 61% of the respondents (Cawelti, 1994). In a review of interdisciplinary teaching, Adler and Flihan (1997) write:

> Overall, the literature suggests that participation in an interdisciplinary curriculum is associated with positive changes in achievement, behavior and attitude. These changes are claimed to occur regardless of how the interdisciplinary program is designed and implemented or who participates in it. In fact, it seems that every type of student has something to gain from the interdisciplinary curriculum. (pp. 31-32)

Clearly these researchers are referencing the impact interdisciplinary teaching has on both the cognitive and affective domain of students. Additionally, interdisciplinary programs are associated with long-term positive outcomes. Evidence suggests that high school students exposed to these kind of programs have performed better in college and exhibited more positive attitudes towards learning and intellectual curiosity (Adler & Flihan, 1997; Aiken, 1942; Tanner, 1989). The above should be tempered by the fact that most of the studies claiming academic improvement and enhanced student attitude are not considered by some to be substantiated by rigorous research methods and analyses (Adler & Flihan, 1997).

Interdisciplinary teaching also seems to have an impact on not just students, but teachers as well. The literature reveals that an interdisciplinary pedagogy forces teachers to reconsider their role as an expert of a single discipline. Forcing interaction and collaboration between professionals of differing disciplines can also shift teachers' attitudes towards teaching. These shifts are reported to be positive and result in teachers describing themselves

as having a renewed enthusiasm and enjoyment towards their work (Adler & Flihan, 1997; Muncey & McQuillan, 1996).

Reviews of professional publications have identified the number of disciplines combined and the type of disciplines that are most commonly blended in interdisciplinary curricula. The literature reveals that the majority of interdisciplinary curricula seem to combine either two or three disciplines. Rare is the program combining four or more disciplines (Adler & Flihan, 1997). Further, English appears to be the common denominator in these programs with it being most commonly combined with history and/or social studies, followed by math, science and health. Also, other instructional programs focused on integration within a single discipline, combining biology and chemistry, for example (Adler & Flihan, 1997).

Interdisciplinary Teaching in Human Anatomy Education

In the sphere of undergraduate, graduate, and professional school (i.e., medical school) level human anatomy, however, there is a paucity of scholarly discourse relating to interdisciplinary teaching. Moore and Brown (2004) acknowledge that there is indeed a call to reintegrate the sciences, especially human anatomic studies at the college and university level, with the humanities. The term "reintegrate" is significant, considering that historically anatomical investigation was not considered science as we think of it today, but rather, a subject inextricably linked with philosophy and other, what were considered to be related disciplines such as astrology. Indeed, students in medieval and Renaissance universities were students of both medicine and philosophy and studied for a degree in both subjects combined (Cunningham, 1997). This point is eloquently demonstrated by Carlino (1999):

> Familiarity with anatomy, however, was not the exclusive preserve of physicians ...the question of how the human body was made pertained as much to philosophy as to natural science, according to the ancient and the Renaissance texts. This is an extremely important point not only for the development of this discipline in antiquity, but also for fifteenth- and sixteenth-century authors ... Renaissance writers on anatomy never failed to remind their readers and students that the discipline had allegiance to both camps, the medical and philosophical. (p. 125)

In quoting Berengario da Carpi, one of the Renaissance's most renowned anatomists, Carlino (1999) continues:

> Berengario, after declaring that anatomy was necessity of theoretical medicine (in search for the cause of illnesses) and for practical medicine (in their cure), wrote: "The utility and necessity of anatomy not only is required knowledge for the physician but also for the philosopher probing the secrets of nature." (p. 125)

The point of how historically, university students of human anatomy were more than scientists per se is further illustrated by Moore and Brown (2004):

> The intersection between anatomy, art, and religion has frequently resulted in a conflict between different views of the human body and of what it means to be human. The anatomist historically has stood at this intersection, often striving to integrate quite disparate roles – scientist, artist/dramatist, and priest/prophet. (p. 8)

This nexus between anatomy and the humanities (i.e., history, philosophy, religion) is more ancient than the middle ages, and harkens back to the second century writings of Galen who believed that anatomical research was the perfect theology, as well the teachings of Aristotle and Plato that date to six centuries before Christ (Magner, 1992).

It does seem however, that recently there has been an increased interest in including the arts in human anatomy at the college and university level. This can be seen in the professional literature, and the popular culture as well. For example, a recent single issue of *The Anatomical Record Part B: The New Anatomist*, which is a publication of the American Association of Anatomists (AAA), a professional organization of medical school anatomists, devotes half its articles to the historical, ethical, artistic, and cultural heritage of human anatomic studies.

For example, Morgan (2004) writes of the social origins of an embryo that dates back to 1914. This embryo is considered by many to be the most famous human embryo specimen in the world. The article outlines the history of how this specimen was obtained via hysterectomy from a 25-year-old woman who was severely hemorrhaging. Neither doctor nor patient was aware of the embryo inside her, yet upon discovery, it was harvested from her removed uterus without her knowledge. The saga of how over the decades this specimen went on to be preserved, photographed, sliced, disseminated and rendered into 3D, is testimony as to how the cultural attitudes towards embryo specimens, as well as concerns for informed consent, have changed in the past century (Morgan, 2004). Why would this story be of interest to professional anatomists if it were not for a belief in the value of linking human anatomy with its cultural past?

Another article in this issue focuses on the *Body Worlds* museum exhibit of Gunther von Hagens that has traveled throughout Europe, Asia (Moore & Mackenzie, 2004) and more recently, North America. The von Hagens exhibit displays human cadavers that are preserved via plastination; a process that removes the water and lipid from tissues and then impregnates the specimen with resins. The result is an odorless, dry, rubber-like, and eternally preserved

cadaver. Controversy surrounds *Body Worlds* because it displays human remains to the lay public in what has been described as sensationalized and dramatic poses that can be considered by many to be disturbing. While the dissections can be described as exquisite, the exhibit has the potential for, at the least, a circus type atmosphere (Moore & Mackenzie, 2004). The thrust of the article by Moore and Mackenzie (2004), at least in part, is to somehow identify the role of *Body Worlds* in the cultural, artistic, and religious history of human anatomy studies. Relevant issues in this piece surround concerns such as who should be the recipient of anatomical knowledge. Should this knowledge be reserved for the privileged few in medical school prosectoriums, or should human anatomy be on display for the general public? Clearly this is a lesson in interdisciplinary education. Comparing this 21st century discourse with the earlier quoted Renaissance writings of Berangario in an anatomy class is likely to provoke a centuries old discussion that would enrich that day's lesson.

A final example of this recent "reintegration" of the humanities into human anatomy education can be found in an undergraduate text. Each chapter of Tortora's (2002) *Principles of Human Anatomy* contains an image relevant to the cultural past or present of human anatomy. Expanding on multicultural themes, images range from 15th century Islamic skeletal renderings, to 21st century computer generated abdominal cross sections. A thought-provoking essay surrounds each image on the page. In an effort to describe the purpose of this component of the text, the preface states:

> These essays, while tied to the chapter, are intended to also go a step further. Students will gain insight into the historical saga of anatomical studies, view images that reflect the evolution of the scientific method, and understand that the current body of anatomical knowledge is by contributions from the whole world. With visually

> beautiful images from Africa, Malaysia, Europe, and Japan, students are likely to "see themselves" and perhaps be more excited about their studies. (p. IV)

The above two journal articles in tandem with the referenced undergraduate human anatomy text support the notion that there is, at the least, a contemporary leaning towards blending cultural themes and human anatomy education. Just how isolated these instances are, is a question that is difficult to answer. It seems safe to say that the human anatomy literature is certainly not replete with examples of interdisciplinarity that aims to influencing the students affective domain. Ironically, perhaps, such a trend could reunite human anatomic studies more with its heritage.

Summary - Interdisciplinary Teaching in Human Anatomy Education

A summary of the literature presented above reveals that the practice of interdisciplinary education and the research supporting it is most frequent at the elementary and secondary school level. Indeed, there is a dearth of peer-reviewed studies that address interdisciplinary education at the college and university level. Generalizing the results from studies using elementary or high school pupils to college and university students seems inappropriate. A reasonable concern is that college students likely represent a subset of the best and brightest of high school students and subsequently, affective and cognitive effects may be more profound if they are studied directly.

Further, the literature also reveals that biology, and human anatomy in particular, is rarely combined with the humanities, although it seems this is beginning to change. Perhaps the higher education paradigm of discipline experts working autonomously and segregated from experts in other disciplines within the framework of college and university departments makes interdisciplinary pedagogy difficult. That notwithstanding, the literature seems to

support the notion that it is warranted to investigate the impact of interdisciplinarity on Krathwohl's (1964) affective domain model in community college human anatomy students.

CHAPTER 3: RESEARCH METHODOLOGY

Introduction

As stated earlier, the purpose of this study was to investigate the relationship between interdisciplinary teaching and science education. This project has attempted to connect art and science by examining the relationship between a lecture about the cultural, historical and artistic heritage of anatomic studies in a community college human anatomy class on affective learning outcomes of students. Achieving that end required the selection of appropriate subjects, the development of a measurement instrument, the collection of data, and the employment of appropriate statistical models. The remaining portion of this chapter will speak to these methodological elements.

Subjects

The subjects in this study were students at the San Diego Miramar College campus of the San Diego Community College District (SDCCD) who were enrolled in either Biology 160: Human Anatomy and Physiology or Biology 230: Human Anatomy. These students were selected as research subjects for this project because they were a representative sampling of community college human anatomy students. Further, each of these classes had an enrollment of approximately 24 students due to the laboratory component of the courses. So as to achieve a sample size of greater than 100 students, which was the aim of this project, it was required to garner subjects from six different sections of anatomy courses taught at San Diego Miramar College.

The majority of these students were preparing for careers in nursing and other allied health careers such as paramedic, x-ray technician, and physical therapy technician. Other students were enrolled so as to academically support their pursuit of careers in medicine,

dentistry or pharmacy. A small minority of students was not pursuing health related careers per se and was enrolled so as to fulfill the life science requirement for either an associates or bachelors degree.

Research Design

The research design for this project has been described in the literature as a One-Shot Case Study (Campbell & Stanley, 1963; Isaac & Michael, 1995). Essentially the subjects were exposed to an intervention in the form of an interdisciplinary lecture, and then administered a posttest to gauge the impact of the aforementioned intervention. This design has been described as pre-experimental due to its lack of subject randomization to control and experimental groups (Campbell & Stanley, 1963). The nature of the research questions and the inherent characteristics of the anatomy courses associated with this study, however, make it very difficult to include these elements. More specifically, considering that affective learning outcomes are not present in existing human anatomy curriculum, it does not seem appropriate to incorporate a control group. The advantage of this research design, however, is that it is proper for a study that is investigating researchable problems or for the development of new ideas or approaches (Isaac & Michael, 1995). Considering the lack of research in the area of interdisciplinary teaching in human anatomy education, a One-Shot Case Study can serve as an initial starting point for further investigation in this area.

Data Collection Procedures

The interdisciplinary intervention (described below) was implemented at the end of the second class session for each of the six classes that participated in the study in the fall semester of 2005. The rationale for this is that it would be best for the intervention to be experienced at the beginning of the semester prior to the students being overly influenced by

other variables (course content, instructor, ancillary readings). Three of the classes were Biology 160: Human Anatomy and Physiology courses and were taught by the author of this study. Two other colleagues instructed the remaining three classes, which were Biology 230: Human Anatomy courses. The interdisciplinary intervention was delivered and data was collected in the same human anatomy laboratory classroom for each class. This laboratory seats 24 students (six laboratory benches with four seats each). Five of the classes had 24 students participate; one class had 25 students participate. Subsequently, 145 students served as subjects. The images of the interdisciplinary intervention were projected to a large screen, approximately six feet high by four feet wide, in the front of the room.

Prior to exposure to the interdisciplinary intervention, students were verbally informed that they were being asked to participate in a research project for a doctoral dissertation and that they had the option to not participate. They were also told that nonparticipation was without penalty of any kind, that they could withdrawal at any time, and that there were no risks of any consequence to participation. They were then given an informed consent form that they were asked to read. Once students had time to read the form, they were asked to sign the form if they chose to participate. All forms were then collected. Students were also given a copy of this form to keep for their own records. Students had the opportunity to leave the room, or to listen to the presentation and select not to complete the questionnaire. A copy of the informed consent form is attached to this document as Appendix B.

Each of the six courses that were sampled were done so in as consistent a manner as possible. The interdisciplinary intervention was at all times delivered by this researcher, in the same manner, in the same room, at the same point in the semester.

The Interdisciplinary Intervention

The interdisciplinary intervention was a lecture addressing cultural and historical characteristics of human anatomy investigation in medieval and Renaissance Europe. This lecture was supported by images from each era that depicted human dissection in a university human anatomy theatre. The interdisciplinary intervention was intended to influence the students' affective domain. Due to the brief nature of the intervention, however, the lecture was not specifically tailored to address each category and subdivision of the affective domain.

Rationale for the First Image

Once the informed consent procedures were completed, the researcher displayed on a projector the first of two images that are artistically and culturally relevant to the history of human anatomic studies. The first of these two images is attached to this document as Appendix C. This image is found in the 1493 edition of the human anatomy text *Fasciculus Medicinae* by Johannes de Ketham. At this time the researcher commenced a lecture that described the cultural, historic and artistic significance of this image framed within a context that is relevant to present day human anatomy students. Once this component of the lecture was complete, the second image was projected.

This second image is the frontispiece to the 1543 human anatomy tome *De Humani Corporis Fabrica* by Andreas Vesalius. The image is attached to this document as Appendix D. The cultural, historic and artistic significance of this image was described. The framework for this portion of the lecture focused more so on how this second image represents a shift in how human anatomy was studied as a result of cultural influences that commenced since the

rendering of the first image. The complete outline for the lecture is attached to this document as Appendix E.

Each of the images was chosen for an array of reasons, not the least of which, arguably, is that the two single most important anatomists of the last 700 years are portrayed in these renderings. Further, these anatomists are depicted in an anatomy-teaching situation. One could argue they are in what students refer to today as anatomy lab. Finally, each image is replete with an iconography that represents the state of anatomic studies in its respective era. These icons shift from one image to the next as testimony as to how our view of the human body was changing, how anatomy education at the university level was evolving, and how the modern scientific method was surfacing. One of the major justifications for these two specific images is that they represent a tension between medieval and Renaissance anatomy. These are the major points of the lecture that the subjects heard.

The literature supports the previously stated contention that these images are portraits of the most important anatomists of the last 700 years. As stated earlier, the first image is from the human anatomy text *Fasciculus Medicinae* by Johannes de Ketham. The *Fasciculus* is a collection of texts and images by Ketham, as well as other authors and artists (Carlino, 1999). It can somewhat be likened to a modern day edited book with many different writers contributing chapters, and in this case, images as well. Ketham functioned as editor and as a contributor. The *Fasciculus* served for both medical practice and instruction, and is identified as the first anatomy text with illustrations (Persaud, 1984). The book was highly successful for nearly 100 years and is considered to be one of the founding texts in anatomical science (Carlino, 1999; Persaud, 1984).

A major element of the *Fasciculus* is Mondino dei Liuzzi's *Anatomia*, written in 1316. Essentially, Ketham considered the *Anatomia* to be so noteworthy, that he included it as a component of the *Fasciculus.* So significant was the *Anatomia* that it was the model for all anatomizing for two centuries. It is this text, and its frontispiece (Appendix C) that was challenged, and eventually replaced by alternative approaches (Cunningham, 1997). Such approaches are exemplified in the frontispiece of Vesalius' *Fabrica* (Appendix D).

The image in Appendix C, rendered in 1493, introduces the *Anatomia* and is considered to be one of the earliest representations of an anatomy lesson (Carlino, 1999). It depicts Mondino himself, in late medieval Europe, presiding over a dissection. The composition of the scene is intended to serve as an outline of how to conduct a dissection in an academic setting. Mondino serves as the *lector*, the person reciting the anatomical lesson, and is seated in his lofty *cathedra*, condescending to the audience. He speaks in Latin, and details the anatomy of Galen, a second century Greek physician whose copious medical, anatomical and physiological writings served as the foundation of medicine for almost 1500 years. The *Anatomia* is heavily reliant upon Galen, and is therefore fraught with errors in view of the fact that Galen himself dissected only animals due to the Roman prohibitions of human dissection (Magner, 1992). Despite glaring inconsistencies between Galen and what was directly observed, the lesson would be molded within the confines of his writings, which were considered dogma.

Close examination of the image reveals that Mondino directs the *ostensor*, who is pictured in the lower right of the image. The *ostensor* interprets the Latin recited by the *lector* into the vernacular, points with a wand to the referenced anatomy to assure that the *sector*, the man wielding the knife, can make the incision at the appropriate location. Note the

relationship between *lector* and the *sector*; the *ostensor* serves a mediating role between the two. The explanation for this can be appreciated by observing the dress of the *sector* as compared to the rest of the figures in the room. All but the *sector* are donned in long robed academic regalia that denotes their academic status. The *sector*, conversely, wears short robes and is a barber surgeon, the lowest caste of medical professionals. Most likely he is not adequately educated to understand Latin, hence the needed assistance from the *ostensor* (Carlino, 1999). This class system, identified by length of garb, persists in the medical profession to this day; physicians wear long coats, while technicians wear short coats.

The anatomy lesson as conducted by Mondino, and more importantly by his contemporaries during the late medieval and early Renaissance era was a ceremonial and solemn occasion. The Appendix C image illustrates the paradigm of just how anatomy should be taught at the university level. Fifteenth-century statutes of the University of Padua eventually codified this model that was most likely introduced by Mondino when he was teaching medicine at the University of Bologna in the early 14th century (Carlino, 1999). This model was not challenged until the early part of the 16th century by Andreas Vesalius, the subject of the second image (Appendix D).

Rationale for the Second Image

The second image (Appendix D) is the frontispiece to Vesalius' *Fabrica*. Publication of the *Fabrica* in 1543 "marks the beginning of modern science. It is without a doubt the greatest single contribution to the medical sciences, but it is a great deal more, an exquisite piece of creative art" (Saunders & O'Malley, 1982, p. 19). This piece is quintessentially Renaissance and elegantly blends art and science. Ornate Corinthian columns dominate the background and putti clutch an armored shield at the top while at the center of the image an

anatomy lesson commences. The remaining pages of the *Fabrica* abound with similarly elegant renderings of human anatomy. Skeletons and progressively dissected musclemen dance and pose in the countryside; human anatomy had been reborn and came alive. The *Fabrica* stands in stark opposition to both the *Fasciculus* and the *Anatomia*. Its frontispiece is a metaphorical call to arms and is intended to advance anatomy beyond the medieval paradigm. Vesalius considered himself the leader of this advancement towards modern day science.

The contrast between the two images at the center of this discussion is striking. Ketham's image of Mondino's anatomy lesson portrays an orderly, private occasion. Vesalius' rendering, conversely, depicts a public, almost theatrical and turbulent event. However, like Mondino's anatomy lesson, Vesalius' image also abounds with iconography. Signifying a break with the previous paradigm, Vesalius descends from the *cathedra* and not only associates with his students, he conducts the dissection himself. The menial *sectors* are relegated to beneath the dissecting table and quarrel as to who will sharpen the professor's blades. Animals, the object of Galen's dissections and the foundation of Mondino's anatomy, are dispensed to the periphery. Direct observation of human anatomy is central; as is its placement on the page.

It has been implied that this rendering is more than just bold, being arrogant as well. Note that in essence all eyes, including the cadaver's, are on Vesalius and that he is the center of attention. He is the only person in the image that gazes out to the viewer. Further evidence of this conceit surrounds the allegory associated with the robed figures. Several historians contend that these figures, dressed in sandals and robes unlike everyone else, are intentionally drawn larger because they symbolize the anatomy giants of classical antiquity:

The Ancients (Cunningham, 1997, Saunders & O'Malley, 1982). The figure on the right, it has been posited, is Aristotle, gazing backward at animals. The two on the left may be Galen (in the foreground) who is blocking all but the head of Hippocrates. Vesalius renders himself as the resuscitator of their practice. "Their presence and approval makes Vesalius one of them: he is a Modern Ancient" (Cunningham, 1997, p. 127).

Vesalius' vanity in tandem with the perceived heretical nature of the *Fabrica*, inasmuch as it identified hundreds of Galenic inaccuracies and challenged the statues of Padua, resulted in envy by his peers and cries of blasphemy by his mentors. Nevertheless, Vesalius was embraced by his students, and while crumbling the dogma of Galenic anatomy, laid the foundation for modern anatomizing. His method of anatomy insisted on repeated and direct observation of humans as opposed to animals, and was combined with a belief that dogmatic teachings should be critically evaluated in light of modern observations. This tension can be described as a "debate over authority which Vesalius and his followers initiated in challenging Galen's observations by an appeal to the body rather than to the text" (Sawday, 1995, p. 133). Vesalius is the father of the modern anatomy and represents, one can argue, a secularizing of the discipline. Anatomy was now beginning to loosen its fastenings to the Ancients and evolve into a modern science.

Summary – Rationale for the Images

The above rationale, in the mind of this researcher, sufficiently justifies the use of these two images to illustrate late medieval versus early Renaissance anatomy education. The Mondino image is a classic depiction of late medieval anatomizing, while the Vesalius frontispiece is emblematic of Renaissance anatomy. It was certainly an option to clutter this conversation with dozens or perhaps scores of related images. The result, however, was

likely to be a rushed and disjointed presentation that would have been difficult for the student to assimilate. These two powerful images however, provided the opportunity for an elegant and effective lecture that connected art and science. It is the belief of this researcher that it is wholly appropriate for this pair to serve as the visual component of an interdisciplinary lecture intending to influence a student's affective domain.

The Instrument Measuring Influence on the Affective Domain

As acknowledged in the earlier review, instruments found in the literature that attempt to measure student affect, have focused on general themes such as attitudes towards science (i.e., science coursework and careers), attitudes towards scientists, and attitudes towards the scientific method (Aiken & Aiken, 1969; LaForgia, 1988; Munby, 1980; Schibeci, 1984). Studies measuring attitudes, as defined as open-mindedness, tolerance to the views of others, honesty and skepticism, as identified by Gardner (1975) as well as Schibeci (1984) has also been investigated. It was also identified that of over 200 instruments designed to measure any of a variety of attitudes towards science, very few were used more than once and only a handful showed any kind of satisfactory statistical reliability or validity (Munby, 1980). Suffice it to say, the literature does not present any kind of well tested and widely accepted instrument which is grounded in the original Krathwohl model of the affective domain that is geared to measure specific attitudes "which emphasize a feeling tone, an emotion, or a degree of acceptance or rejection" as it relates to the unique relationship between art and science (Krathwohl et al., 1964, p. 7). This being the case, it seemed reasonable to conclude that an instrument based upon Krathwohl's model (Krathwohl et al., 1964) should be devised by this researcher that speaks directly to students in anatomy classes

who have just been exposed to interdisciplinary themes surrounding the relationship between art and science. Appendix F contains such a model.

This questionnaire, as stated above, is grounded in the original model of the affective domain (Krathwohl et al, 1964.). What can be seen in Appendix F is that each question that was asked of the students is based upon educational objectives from this text. The left hand column identifies affective educational objectives that are excerpted from Krathwohl et al., (1964). The right hand column lists the questions that are grounded in these objectives.

These objectives address the first four of the five affective domain categories. The fifth and highest category, Characterization by a value or value complex, and its two subdivisions, Generalized set and Characterization, are intentionally not included. It is unreasonable, and perhaps even folly, to believe that a one-hour lecture could impact this level of the continuum. It is here that an individual develops unique personal characteristics and realizes a philosophy of life. In the original taxonomy Krathwohl et al., (1964) writes:

> Rarely, if ever, are the sights of educational objectives set to this level of the *Affective Taxonomy*. Realistically, formal education generally cannot reach this level, at least in our society. In all open and pluralistic societies, such as our own, the maturity and personal integration required at this level are not attained until at least some years after the individual has completed his formal education. Time and experience must interact with the affective and cognitive learnings before the individual can answer the crucial questions, "Who am I? and "What do I stand for?" (p. 165)

As a result of this foundation for the fifth category, it was not included in the instrument that attempts to measure the influence of the interdisciplinary module on the student's affective domain. It is certainly within the realm of possibilities, however, that there was an individual

in the study who was older, had completed his or her formal education, and therefore had developed the capacity to engage at this level. That being said, it seemed much less likely that this individual would also have been exposed to this concept addressing the relationship between art and science. It also seemed extremely remote that enough such individuals existed at the community college level to warrant including this category in the questionnaire.

In addition to these questions addressing the affective domain, students were asked a series of demographic questions. The demographic questionnaire is attached to this document as Appendix G. The affective domain questionnaire, including directions as to how to complete the Likert rating scale, is attached to this document as Appendix H. These demographic questions were included so as to determine if demographic variables function as an independent variable (manipulated) that is related to certain components of the affective hierarchy as a dependent variable (responding).

It should be noted that San Diego Miramar College was aware of and gave approval for this project to be conducted. It should also be noted that the researcher had completed training to assure the protection of the human subjects. Documentation of the approval by San Diego Miramar College is provided in Appendix I. This is a letter from the dean of the department in where this research was conducted. The human subjects protection training documentation is provided in Appendix J. This documentation demonstrates that the researcher completed the National Cancer Institute's Human Participant Protections Education for Research Teams online training. The Institutional Review Board of the University of San Diego requires this training. Finally, Institutional Review Board approval for the use of human subjects is provided on page iv of this volume.

Statistical Analysis of Data

Information from the questionnaires was entered into the software package SPSS version 11.0 for Mac OS X. Responses to the affective domain component of the questionnaire were entered as the numeric values. Each question was assigned its own variable. Demographic data was entered into the SPSS program. Certain demographic responses were directly entered since the responses are numeric, such as age and GPA. The nature of the majority of the responses required a coding system. Dummy variables were therefore utilized for most of the demographic information. For example, female = 0, male = 1; no = 0, yes = 1.

Data for each of the four affective domains were averaged resulting in four dependent variables. A fifth dependent variable that represents an overall affective domain score was also generated. To do so, an average score for the entire affective domain was determined. This resulted in a total of five dependent variables. Mean scores and standard deviations for each of these variables were generated. Statistical tests were conducted between each of these five variables in a matrix-like manner to determine if students rated any one of these five variables significantly higher. Regression analysis was also performed between the five affective domain variables as dependent variables and each of the demographic variables as independent variables.

For affective domain questions on the surveys that were left unanswered, the mean score for all other responses to the same question on the survey were used. Demographic questions that were numeric in nature (i.e., age, number of units completed) and were left unanswered, the mean score for all other responses to the same question on the survey were used. This zero order correction technique is the most unbiased correction procedure. If

dummy variable data is unanswered (i.e., gender) this was left blank and not included in the regression analysis.

CHAPTER 4: DATA RESULTS AND ANALYSIS

Introduction

As mentioned above, the purpose of this study was to investigate the relationship between an interdisciplinary science education strategy and a set of pre-defined educational objectives. More specifically, this study attempted to connect art and science by examining the relationship between a cultural, historical and artistic lecture in a community college human anatomy class on the affective learning outcomes of students. In this chapter, results of the student survey will be presented, together with an inferential analysis that helps explain why some students appeared to have benefited more from the intervention than others. This discussion begins with a description of the student demographic data and then moves on to the affective domain analysis, where both descriptive statistics and multiple regression analysis are used.

Results and Analysis

Demographics

In this section, the sample will be described from a demographic perspective, including the student's age, gender, ethnicity, educational level, and current GPA. This distribution will also be compared to the overall student population at Miramar College. To determine the extent to which generalizations from this study are appropriate, the most recent published enrollment data by the San Diego Community College District (SDCCD) for the fall semester of 2005 (the semester that data was collected) will be used for this comparison (San Diego Community College District, 2006).

The gender of the subjects that participated in this study is identified in Table 1. This table shows that 60% of the sample was female and 40% male – essentially the opposite of

the actual San Diego Miramar College student profile. Miramar College has a ratio of approximately 55% male to 45% female (San Diego Community College District, 2006). A simple explanation as to why the subjects in this study were disproportionally female is almost certainly due to the amount of male-dominated vocational programs offered at the school. Specifically, Miramar College offers vocational coursework in firefighting, law enforcement, automotive and diesel technology, and aviation technology. Traditionally, these programs enroll many more male students than female. Conversely, the majority of the subjects in this study are enrolled in anatomy classes that serve as prerequisite coursework for acceptance into nursing programs. Traditionally, nursing students are mostly female. While the subjects in this study may not be gender representative of the college as a whole, it seems sensible to deduce that they are indeed representative of the population of anatomy students. Furthermore, the gender distribution of the sample is near identical with national trends that identify females as comprising the majority of college students. Recent federal data reports that 57% of college undergraduates are female, while 43% are male (U.S. Department of Education, 2005).

Table 1

Student Gender and GPA – Study Subjects and Miramar College Students

	Study Subjects (N=145)			Miramar College (N=10,135)		
Gender	Number	Percent	GPA*	Number	Percent	GPA**
Male	58	40.0%	3.04	5,850	57.7%	2.95
Female	85	58.6%	3.22	4,274	42.2%	2.85
Declined	2	1.4%	----	11	.1%	1.98

*Student reported cumulative GPA **Term GPA

Table 1 also shows the average GPA for males and females. Interestingly, females had a higher average GPA than the males (3.22 versus 3.04), again running counter to the overall student population at Miramar College where males have a slightly higher GPA than their female counterparts, 2.95 to 2.85 respectively (San Diego Community College District, 2006). While only .10 grade points separate the GPA of the genders in the Miramar College population, the difference of .18 grade points in the study sample in the opposite direction suggests that this sample may not be representative of the entire student body. It is unclear as to why this disparity exists, considering that nationwide, female college students on average have a higher GPA (Chacko, 2005). It seems that the GPA of the students in this study, are more consistent with national trends than campus tendencies.

Table 2

Student Ethnicity – Study Subjects and Miramar College Students

	Study Subjects (N=145)		Miramar College (N=10,135)	
Ethnicity	Number	Percent	Number	Percent
African American	3	2.1%	514	5.1%
American Indian	0	0.0%	95	0.9%
Asian/Pacific Islander	27	18.6%	1,447	14.3%
Filipino	26	17.9%	1,102	10.9%
Latino	12	8.3%	1,360	13.4%
White	62	42.7%	4,355	43.0%
Other	13	9.0%	390	3.8%
Declined	2	1.4%	872	8.6%

The ethnicity of the students in the study is reported in Table 2. Consistent with the overall Miramar College demographics, a plurality of the students in this study were White. Interestingly, while the SDCCD reports that Miramar College has an 11.4% Filipino enrollment, almost 18% of the students in this study were from this ethnic category (San Diego Community College District, 2006). Further, students of Asian/Pacific Island background were also slightly over represented. Compared to the reported campus-wide Asian/Pacific Island student population of 14%, almost 19% of the subjects in this study reported being of this ethnicity.

Conversely, Latinos were somewhat underrepresented. While the Miramar College student population of Hispanics is approximately 12%, only 8.3% of the subjects in this study were Hispanic (San Diego Community College District, 2006). The same can be said for African American students. These students were only 2.1% of the research subjects, yet they are almost 6% of the Miramar College student population (San Diego Community College District, 2006). This may be evidence to support the notion that a disproportionate number of Filipino and Asian/Pacific Island students are preparing for careers in nursing (and other allied health professions), compared to Hispanic and African American students. The following chapter explores this notion more fully.

Table 3

Student Educational Level – Study Subjects and Miramar College Students

	Study Subjects (N=145)		Miramar College (N=10,135)	
Highest degree earned	Number	Percent	Number	Percent
No HS diploma/HS student	0	0.0%	813	8.0%
High school diploma/GED	81	55.8%	6,721	66.3%
Associates degree	29	20.0%	977	9.6%
Bachelors degree or higher	33	22.8%	1,624	16.0%
Declined/Unknown	2	1.4%	0	0.0%

Student educational level is reported in Table 3. The students who participated in this study had completed more education than the typical student enrolled at Miramar College. For example, Table 3 shows that almost 43% of the subjects had an associates degree or higher compared to almost 26% of the general student population (San Diego Community College District, 2006). It seems reasonable to conclude that students preparing for nursing careers at Miramar College are considerably more formally educated than the average Miramar College student.

Table 4 below describes the age distribution for the sample. Despite the fact that these subjects completed more formal education, they are somewhat younger than the typical Miramar College student. The vast majority of the research subjects are between 18 to 24 years old (61%). The campus at large, however, has over 45% of students falling into or below this age category. Further, while only 8.3% of the subjects were 40 years old or older, 19% of the campus population is (San Diego Community College District, 2006). Perhaps the basis for this is that the typical Miramar College student is an older individual, who never

completed formal education, and is returning to school. This is most likely true of community college students in general. The human anatomy students who participated in this study, however, seem to be of an age more typical of undergraduates.

Despite being younger than their Miramar College counterparts, however, these student subjects seem to be more academically advanced. They are further along in their formal education, yet they are younger than the typical Miramar College student. Further, while the subjects report an only slightly higher GPA, it is likely, due to their professional aspirations, that they have completed a more rigorous coursework of math and science than the average student. Indeed, 28% of the students in this study report having already completed three or more biology courses. Higher GPA in tandem with a more rigorous coursework seems to be evidence of significant academic achievement.

Table 4

Student Age – Study Subjects and Miramar College Students

	Study Subjects (N=145)*		Miramar College (N=10,135)	
Age	Number	Percent	Number	Percent
< 18 years	0	0.0%	229	2.3%
18 - 24 years	88	60.7%	4,345	42.9%
25 - 29 years	25	17.2%	1,602	15.8%
30 - 39 years	20	13.8%	1,955	19.3%
40 - 49 years	9	6.2%	1,397	13.8%
≥ 50	3	2.1%	528	5.2%
Unknown	0	0.0%	79	0.8%

*Mean age = 26.1 years

In summary, while the subjects in this study are not an exact profile of the characteristic Miramar College student, they do seem to be representative of community college human anatomy students who are likely to be pursing careers in nursing, or other allied health professions. Demographically, the students in this study are majority female, ethnically diverse, well educated, academically successful, and of typical undergraduate age.

Affective Domain

The subjects in this study were exposed to an interdisciplinary intervention that was intended to influence their affective domain. The 21 affective domain questions that were submitted to the students were used to compute four affective domain scores as well as a composite affective domain score. For each subject, questions 1 through 5 were averaged and assigned the variable name Receive. Similarly, the mean of questions 6 through 11 were computed and termed variable Respond; the scores for questions 12 through 16 were averaged and given the variable name Value; and finally, the remaining scores for questions 17 to 21 were averaged and termed variable Organize. These four domain scores were then averaged to compute a composite affective domain score, labeled Overall. Appendix F summarizes the categories of the affective continuum and the questions that correspond to each category.

In an effort to determine if the interdisciplinary strategy had an observable effect on the affective domain of the subjects (or any of its categories), the following four statistical methods were employed. First, for each of the 21 individual questions as well as the four domain scores and the composite score, a one-sample t-test was used to test to see if the mean value for each of these was equal to 4, the Likert-scale value in the middle of the choice set, signifying indifference or neutrality. Following that, the bivariate Pearson

correlation coefficient was used to see to what extent the affective domain categories (Receive, Respond, Value, Organize) and the composite affective domain score (Overall) were linearly related. Next, a paired samples t-test was used to identify if there was a difference between the overall mean scores for each domain category and the composite score. Finally, stepwise regression analysis was used to determine the extent to which the demographic measures helped explain variation in the affective domain categories. During this analysis, the mean scores for the affective domain variables served as dependent variables and the demographic data served as independent variables.

Table 5 identifies the descriptive statistics for responses to each category and associated subdivision of the affective domain. It can be seen when examining the range that each question has a minimum of 1.00 and a maximum of 7.00, which can be interpreted to mean that there was some diversity in the responses. The most compelling data in this table are the mean scores. Note that there is not one score below a 4.0, the middle value of the Likert-type questions.

Table 5

Affective Domain Categories, Questions, and Responses – Descriptive Statistics (N=145)

Domain Category	Question	Mean	SD	Range
1.0 Receiving				
1.1 Awareness	1. After today's lecture, I am now much more aware that human anatomy has a cultural, historical, and artistic heritage.	6.17	1.14	1.00 – 7.00
1.1 Awareness	2. I was so interested in the topic being presented today that I listened attentively throughout the lecture.	6.01	1.34	1.00 – 7.00
1.2 Willingness to receive	3. I am now more willing to attend lectures discussing the link between art and science.	5.44	1.45	1.00 – 7.00
1.3 Controlled or selective attention	4. I was so impressed with the images presented in the lecture that I hardly took my eyes off of them and I rarely found my mind wandering.	5.54	1.48	1.00 – 7.00
1.3 Controlled or selective attention	5. I am now more likely to look at images examining the relationship between art and science.	5.57	1.14	1.00 – 7.00
2.0 Responding				
2.1 Acquiescence in responding	6. When I was informed that today's presentation would examine a link between art and science, I had no real feelings of resistance to listening to the lecture.	5.46	1.50	1.00 – 7.00
2.1 Acquiescence in responding	7. If I the opportunity to discuss another topic today, I very well many have been more interested in that.	4.28	1.82	1.00 – 7.00

Table 5 (continued)

Affective Domain Categories, Questions, and Responses – Descriptive Statistics (N=145)

Domain Category	Question	Mean	SD	Range
2.0 Responding				
2.1 Acquiescence in responding	8. Now that I have heard the lecture, I am more open to future discussions linking art with anatomy despite other options that may be before me.	5.53	1.31	1.00 – 7.00
2.2 Willingness to respond	9. After today's lecture, I am now more likely to independently seek out and read books or articles as well as ask questions of my professors about the cultural, historical, and artistic aspects of human anatomy and other sciences as well.	4.60	1.53	1.00 – 7.00
2.3 Satisfaction in response	10. I truly enjoyed today's lecture discussing the cultural, historical, and artistic aspects of human anatomy.	6.00	1.29	1.00 – 7.00
2.3 Satisfaction in response	11. I am likely to take greater pleasure in further examination of this in my anatomy class as well as my other science classes.	5.28	1.54	1.00 – 7.00
3.0 Valuing				
3.1 Acceptance of a value	12. Today's presentation contained so much valuable information that I am now more likely to initiate conversations with my family and friends about how there is a strong connection between art and science.	4.87	1.63	1.00 – 7.00
3.2 Preference for a value	13. By virtue of today's presentation, I now place an extremely high value on the relationship between science and the humanities.	5.32	1.33	1.00 – 7.00
3.2 Preference for a value	14. I am now more likely to read books and/or visit museum exhibits about science history.	5.01	1.69	1.00 – 7.00

Table 5 (continued)

Affective Domain Categories, Questions, and Responses – Descriptive Statistics (N=145)

Domain Category	Question	Mean	SD	Range
3.0 Valuing				
3.3 Commitment (conviction)	15. I feel such commitment to the ideas presented in today's lecture that I will now share these ideas with my family and friends.	4.75	1.63	1.00 – 7.00
3.3 Commitment (conviction)	16. I will also attempt to convince my family and/or friends that science and art are strongly linked and that this concept is extremely important to understand and value.	4.43	1.67	1.00 – 7.00
4.0 Organization				
4.1 Conceptualization of a value	17. I found the symbolization in the images presented today to be fascinating.	6.07	1.19	1.00 – 7.00
4.1 Conceptualization of a value	18. By virtue of the presentation I am now likely to speculate what other meanings these symbols may have beyond the explanations presented in the lecture.	5.22	1.43	1.00 – 7.00
4.1 Conceptualization of a value	19. I am now more likely to form judgments as to how the meaning of these symbols represents the ethical or moral role of science in society.	5.17	1.38	1.00 – 7.00
4.2 Organization of a value system	20. Today's lecture has changed my philosophy of higher education.	4.88	1.48	1.00 – 7.00
4.2 Organization of a value system	21. I now believe that all college classes, not just science classes, should be founded in an approach that examines relationships between the subject being primarily studied, and its connection with other disciplines	5.80	1.37	1.00 – 7.00

Table 6 presents the descriptive statistics for each of the four affective domain categories (Receive, Respond, Value and Organize), as well as the composite score (Overall). As was indicated earlier, each of the questions the subjects responded to were Likert-type, with a scale from one to seven. The middle value for each response, therefore, was four. As can be seen in Table 6, the mean score for each of the categories is indeed above four. In fact, all of these values, except for one, were above five. This was especially true in the Receive category (the lowest category of the hierarchy).

Table 6

Domain Categories – Descriptive Statistics (N = 145)

Category	Mean	SD	Minimum	Maximum
Receive	5.75	1.08	1.80	7.00
Respond	5.12	0.97	2.50	7.00
Value	4.88	1.37	1.40	7.00
Organize	5.42	1.11	1.40	7.00
Overall	5.31	1.03	1.98	6.88

To statistically verify, however, that these means were significantly different from the value of "4", a one-sample t-test was used. As shown in Table 7, all of these differences were significant at the p=.00 level, suggesting that these students gained in all four affective dimensions as a result of exposure to the interdisciplinary intervention.

So as to determine if the mean scores of the affective domain categories had any relationship between each other, further statistical tests were performed. Table 8 identifies the results of the paired samples correlations test. In this procedure, the mean scores for each

of the domain categories were compared in a matrix-like manner. The results of this test demonstrate an extremely robust correlation between domain categories, as well as the composite domain score. The results of this test reveal that if a student rated one domain high, s/he was also likely to rate another domain high. This is especially true when Overall is compared to the four domain categories. Note that the correlations are .90 or greater when Overall is paired with any other category. It can be confidently stated that if a student was impacted by the interdisciplinary strategy at any level of the affective continuum, it is almost certain that s/he was impacted throughout the continuum. Further, his/her composite score (Overall) is high as a result of scoring high in all categories of the affective domain continuum.

Table 7

One Sample T-Test Against Test Value of 4 (N=145)

Category	Mean	Mean Difference	t	Sig. (2-tailed)
Receive	5.75	1.75	19.44**	.00
Respond	5.12	1.12	14.73**	.00
Value	4.88	0.88	7.67**	.00
Organize	5.42	1.42	15.45**	.00
Overall	5.31	1.31	15.27**	.00

**p< .01

Table 8

Paired Samples Correlations (N = 145)

Pair	Correlation	Significance
Receive - Respond	.84	.00
Receive - Value	.76	.00
Receive - Organize	.78	.00
Receive - Overall	.92	.00
Respond - Value	.77	.00
Respond - Organize	.74	.00
Respond - Overall	.91	.00
Value - Organize	.75	.00
Value - Overall	.91	.00
Organize - Overall	.90	.00

Table 9 identifies results of a paired samples t-test that determines whether there was a statistically significant difference between domain categories. This test was performed in an effort to order the scores on the four domains. What can be seen in Table 9 is that there clearly is a statistically significant difference between the domain scores, therefore an order can now be established. Table 7 serves as the point of reference to identify that order. Students responded at a greater magnitude in the Receive category, then Organize, Respond, and finally, Value. It should be noted that Overall should not be considered in this ordering because it is a composite of the four domain categories. This ordering reveals that students responded the most at the lowest end of the continuum (Receive), as was hypothesized earlier in the dissertation. Interestingly, however, the second highest category of student response is

Organize, which is the highest level of the continuum. The remaining two categories, Respond and Value, experienced a student response in the predicted order. In essence, students responded the most at the lowest end of the continuum, surprisingly followed by a significant response at the highest end of the continuum.

Table 9

Paired Samples T–Test (N = 145)

Pair	t	Sig. (2-tailed)
Receive - Respond	11.24	.00
Receive - Value	11.76	.00
Receive - Organize	5.40	.00
Receive - Overall	12.54	.00
Respond - Value	4.24	.00
Respond - Organize	-3.65	.00
Respond - Overall	-3.32	.00
Value - Organize	-7.13	.00
Value - Overall	-8.63	.00
Organize - Overall	2.73	.01

The second research question that guided this dissertation was directed at determining if demographic variables could predict how a student's affective domain responded to the interdisciplinary intervention. To determine the factors that might help explain why some students benefited more from this intervention than others, stepwise regression was used to

identify those demographic variables that helped explain variation in the affective domain scores.

In Table 10 the results of the stepwise regression analysis are presented. Examination of this table reveals that the demographic variables linked with the affective domain are Gender, Latino, Age, and Unsure Dad (subject was unsure of his/her father's educational level). At the lowest level of the continuum, Receive, there were no demographic variables that helped explain how students responded. However, in the Respond category, Latino and Age were identified as significant positive indicators of higher scores. Gender and Unsure Dad (negative relationships) were associated with the Value category, and Gender was positively associated with Organize. Finally, Gender and Latino are positively related to the composite affective domain score.

The demographic variable that most commonly occurs is Gender. It appears in Value, Organize and Overall. Interestingly, this represents the two highest categories of the affective hierarchy, as well as the composite score (Overall). This dummy variable was coded as 0 = female, and 1 = male. Therefore, the negative estimated coefficients (which indicate female), which range from -.408 to -.519 can be interpreted to mean that females scored essentially a half point higher than males in each of these affective domain categories. Furthermore, since Gender was insignificant at the lower ends of the continuum, it can also be argued that males and females responded similarly in the Receive and Respond categories. It is only at the higher ends of the hierarchy, and at a magnitude adequate to also influence the composite score (Overall), that females separated themselves from males.

Table 10

Stepwise Regression Analysis Identifying Significant Demographic Variables for Affective Domain Categories (N = 145)

Category	Variable	B	Std. Error	t
Receive	---	---	---	---
Respond	Latino	.647	.288	2.25*
	Age	.020	.010	1.99*
Value	Gender	-.519	.231	2.25*
	Unsure Dad	-.802	.358	2.24*
Organize	Gender	-.436	.188	2.32*
Overall (composite)	Gender	-.408	.173	2.36*
	Latino	.677	.305	2.22*

* $p < .05$

Latinos also seemed to be more responsive to the interdisciplinary intervention than any other ethnic group. Their Overall score is essentially two-thirds of a point higher (.677) than the other ethnicities. The same can essentially be said for Latinos in the Respond category. The other statistically significant variable in this regression was Age, and it's coefficient of .02 means that an age difference of fifty years among students was associated with a one-point Likert-style difference in responses. Finally, the negative value for the estimated coefficient associated with students who were unsure whether or not their father had graduated from college with a minimum of a bachelors degree (Unsure Dad), tended to

score almost an entire point lower on the Value scale. This result indicates that students, who for whatever reason are unsure of their father's educational level, are less likely to place a high value on the interdisciplinary intervention.

Summary

The following two research questions guided this investigation:

1) How will any component of an undergraduate human anatomy student's affective domain be at all influenced when s/he is exposed to an interdisciplinary lecture that examines selected artistic renderings that explore the historical, cultural, and artistic heritage of human anatomy?

2) Does this influence vary by any one of a number of student demographic variables?

In reference to the first research question, evidence supports the notion that the brief, one-time interdisciplinary strategy intervention did indeed have a positive effect on the student's affective learning outcomes. Subjects in this study responded with scores that had a mean well above four (on a Likert-type scale of one to seven) in each of the four affective domain categories, as well as in their overall composite score. Further, students who did experience a positive effect from the intervention experienced a positive effect throughout the hierarchy.

An examination of the results of the stepwise regression analysis provides information that answers the second research question. Specifically, three of the demographic variables – gender, age, and Latino ethnicity – were found to be significant predictors of the extent to which individuals benefited from the intervention. Individually, gender displayed the strongest relationship, with female students responding most favorably to the

intervention. For example, females scored higher at the upper levels of the hierarchy (Value and Organize) as well as in the composite score (Overall). In both of these affective domain categories, females scored approximately a half-point higher than males. Latino ethnicity demonstrates itself to be a moderate predictor at the Respond category, as well as in the composite score (Overall). Students of this ethnicity tended to rate responses higher by more than a half point for both of these variables. Age proves to be a minor predictor only at the lower end of the affective domain continuum. For each year of increased age, students responded only .02 points higher in the Respond category alone. As was stated earlier, 50 years of age are required to explain a one-point difference in student responses. While this was certainly statistically significant, in practicality the influence of age can be described as negligible.

Prior to conducting this study it was postulated that the interdisciplinary intervention was likely to have its influence at the lower levels of the affective domain hierarchy. The reasoning for this is that the intervention was a brief module (less than an hour) and that it would likely take a semester-long curriculum to influence the higher levels. Examination of the mean scores for each category somewhat supports this hypothesis. The highest score, it can be seen upon examining Table 7, is at the lowest category (Receive). The next highest score, however, is from the highest category (Organize). This circumstance creates what could be termed a "bookend" effect. These mean scores then decline for each of the next two categories, resulting in a trend that is consistent with the original hypothesis. The mean score then increases, as was stated above, for the highest category (Organize). The lack of any demographic predictors for the lowest level of the continuum (Receive) indicates that students responded equally to the interdisciplinary intervention in this affective category.

Finally, the hypothesized significant demographic predictors of age, educational level, and GPA were somewhat supported by the data. Age did statistically reveal itself as a demographic predictor, but it seems to be a weak predictor. Educational level, however, did not. A case could be made that these students are inherently more formally educated than the average student by virtue of the fact that almost 43% of the subjects had an associates degree or higher, which is well beyond what the average Miramar College student has completed. Finally, GPA also did not directly test positive as a predictor for response to the intervention. It is interesting to note, however, that it was female students (who have higher GPAs than males) who positively responded throughout the affective domain continuum, and that the students in this study are pursuing a rigorous, science-based course of study.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

In the preceding chapters, the underpinnings of this study were identified vis-à-vis an overview, statement of purpose, identification of research questions, and review of related literature. Subsequent to that, the research methodology was presented, followed by an examination of the results. In this chapter, the conclusions and inferences from those findings, the recommendations for policy, the implications for future research, and the relationship between affective objectives and mental complexity are discussed.

The purpose of this study was to investigate the relationship between an interdisciplinary science education strategy and a set of predefined educational objectives. This interdisciplinary strategy was in the form of a cultural, historical and artistic presentation in a community college human anatomy class. The educational objectives were those of the affective domain as outlined by Krathwohl et al., (1964). Further, the following two research questions guided this investigation. 1. How will any component of an undergraduate human anatomy student's affective domain be at all influenced when s/he is exposed to an interdisciplinary module that examines selected artistic renderings that explore the historical, cultural, and artistic heritage of human anatomy? 2. Does this influence vary by any one of a number of student demographic variables?

Discussion of Findings

Demographics

Identifying and discussing the demographic characteristics of subjects is significant. If the subjects who participated in this project are representative of college human anatomy students, then the results can be more confidently generalized to the overall community

college human anatomy student population. Further, if these students are not just representative of anatomy students, but the population of undergraduate college students as well, then these generalizations could be applied to all college students. It needs to be reiterated that one of the limitations of this study is that it is not a random sample, but a convenience sample of undergraduate human anatomy students. Subsequently, these distinctions are essential.

The subjects in this study do indeed seem to be representative of community college human anatomy students. They are relatively young, ethnically diverse, and majority female. These subjects also have a high GPA. This profile is essentially consistent with the characteristics expected for a student preparing for a career in nursing. The only initially surprising characteristic is the amount of higher education these students had already completed. Almost 43% had an associates degree or higher, and almost 23% had a bachelor's degree or higher (Table 3). Not only is this more advanced than the typical Miramar College student, it seems reasonable to ask if this is more advanced than the typical nursing student.

Examination of a survey of registered nurses in California, however, makes it clear that the subjects in this study are fundamentally representative of students preparing for nursing careers. Of the students entering their nursing education in California today, 44% have already achieved an associates degree or higher, and 19.5% had a bachelors degree or higher (California Board of Registered Nursing, 2004). These numbers are remarkably consistent with the 42.8% of students in this study who also had an associates degree or higher, and the almost 23% that had bachelors or masters degrees (Table 3). This surprisingly advanced level of education may be evidence that students are entering nursing as a second career.

Further, age at the time of graduation from nursing schools in California is now approximately 27 years (California Board of Registered Nursing, 2004). This age is consistent with the students in this study who were slightly over 26 years of age at the time of their participation (Table 4). Interestingly, this age however, may not be much older than today's typical undergraduate. The California State University (CSU) identifies the average age of its over 400,000 students across its 23 campuses as 24 years of age (California State University, 2005). Thinking of college students as the traditional 18 to 22 year old population is a thought that may need to be reconsidered.

Finally, the ethnicity of the student subjects essentially reflects that of statewide nursing professionals. In California today, nurses are approximately 4% African American, 6% Latino, 16% Filipino, and 22% Asian/Pacific Islander (California Board of Registered Nursing, 2004). The subjects in this study were approximately 2% African American, 8% Latino, 18% Filipino, and 19% Asian/Pacific Islander (Table 2). Statewide, each of the above ethnic groups has experienced increased representation in the last 15 years, while the proportion of Whites has declined (California Board of Registered Nursing, 2004).

Nursing, at least in California it appears, is an ethnically diverse profession, and the subjects in this study seem to represent that. Nurses nationwide, however, do not seem to enjoy such diversity. Although 31% of the US population identifies itself as being a racial or ethnic minority, somewhere between 7% and 12.3% of registered nurses nationally identify themselves as such (McQueen & Zimmerman, 2004; Gardner, 2005).

Gender is the only variable that is not consistent with statewide nursing demographics. While male nurses in California have increased their ranks to 8.3%, women clearly dominate the profession (California Board of Registered Nursing, 2004). The fact that

40% of the subjects in this study were male indicates that it is likely that there were many non-nursing majors in the study. While these males may not have been pursing nursing per se, they certainly were pursing healthcare related professions. Indeed, 98.3% of the males in this study responded that they were preparing for such a career in healthcare. Most likely these students were preparing for medical school, or based on the curriculum offered by the San Diego Community College District, they are pursing careers as paramedics, x-ray technicians, or physical therapy assistants.

Two issues come to mind when discussing the above demographic observations. 1. The subjects in this study were demographically representative of nursing students (and most likely other allied health pre-professionals) in California. It seems appropriate, therefore, to make generalizations from the inferences derived from this study to the overall population of California students in anatomy classes (who are most often preparing for health careers). 2. Generalizations to undergraduates not pursuing health care professions, and generalizations to nursing students outside of California, however, may be problematic.

The concern with generalizing to other undergraduates is that a significant portion of the students in this study (22.8%) already possessed a baccalaureate degree or higher (Table 3). As such, the possibility exists that the subjects responded positively to the interdisciplinary intervention due to their advanced academic standing, or perhaps to their overall level of maturity. Remember that these students had a mean age of 26 years (Table 4). Further, generalizations to anatomy students beyond California, however, could be confounded by the unique ethnic diversity of the subjects in this study. These concerns are somewhat ameliorated by the fact that ethnicity seems to be only a minor predictor of affective domain response to the intervention (Table 10).

Affective Domain

It can be stated with certitude that the interdisciplinary strategy utilized in this project had a positive effect on the affective domain of the participating students. The intervention resulted in a statistically significantly upward shift in all categories of the affective domain hierarchy. This occurred for all subjects in each domain category. The magnitude of the response was greatest at the lowest and the highest categories. This result suggests that the intervention had a positive impact throughout each category of the affective domain.

The above outcomes indicate that there is truly a pedagogical phenomenon occurring in the classroom when interdisciplinary strategies are employed to impact affective educational objectives. Educators should recognize this powerful relationship and exploit it to their advantage. The result is likely to go beyond simple attention or awareness to the introduced ideas, but also progress to "complex but internally consistent qualities of character and conscience" (Krathwohl et al., 1964, p. 7).

These qualities are perhaps the deepest and richest components of a learning experience. In an undergraduate anatomy class, students are likely to quickly forget the nuances of skeletal muscle attachment and the intricacies of cerebrospinal fluid formation and circulation. It is perhaps more likely, however, that these same students will adopt lifelong attitudes about the elegant relationship between the concept formation of human structure and function. These students are likely to develop a positive disposition towards the anatomic sciences due to its rich cultural and artistic heritage. Students can always reference their textbooks for detailed factual anatomic information they have long ago forgotten. They are more likely to hold onto these affective outcomes for a lifetime.

It is to be expected that many educators are reluctant to introduce interdisciplinary elements into their classes because they feel that other course content will be displaced. The challenge for educators is to recognize that affective objectives are worthy of valuable classroom time. Indeed, a paradigm needs to be adopted that considers both affective and cognitive objectives as counterparts, and not competing interests. The authors of the seminal work in this area contend that the affective and cognitive domains are not distinct and separate, but are intertwined (Krathwohl et al., 1964).

Although the fifth category of the affective domain (Characterization by a value or value complex) and its associated subcategories (Generalized set and Characterization) were not measured in this project, it is reasonable to extrapolate the results of this study in that direction. More specifically, as was noted earlier, there was a "bookend" phenomenon where the affective domain subcategory mean scores progressively declined from Receive to Respond to Value (as was predicted prior to the collection of data), but then surprisingly increased in Organization. Considering the maturity of the subjects in this study, as defined as advanced academic level and greater mean age than the average college student, it is instructive to suggest that perhaps the study subjects would have scored even higher in the fifth category of the affective domain. This potential upswing in the two highest subcategories of the affective domain would further buttress the notion that interdisciplinary interventions are effective in influencing affective learning outcomes.

Finally, it is interesting to speculate as to the relationship between the student disposition that results from a positively shifted affected domain via interdisciplinary human anatomy education and his/her performance as a professional. Will a healthcare professional who studies of human anatomy included affective learning objectives now have an

advantageous disposition towards his/her patients? Will he/she be a more well rounded healthcare professional who has a more favorable understanding of human form and function? The above questions are worthy of consideration.

Conclusions

Based upon the findings of this study, the following conclusions can be drawn:

1) Interdisciplinary teaching in the realm of art and science is an effective approach for achieving educational learning outcomes in the affective domain in the tradition of Krathwohl et al., (1964). This approach is well received by the vast majority of students, and impacts the affective domain in all its categories.
2) The affective domain of female students seems to be most responsive to interdisciplinary interventions. This is true at the higher categories of the affective domain hierarcy as well as in the overall score. Latino ethnicity is also related to higher scores, and to a lesser degree, older students are also more responsive to this approach.
3) Human anatomy students at San Diego Miramar College are more educated, slightly younger, and more ethnically diverse than the average undergraduate student at this institution. This demographic profile, while somewhat atypical of San Diego Miramar College students, is indeed representative of nursing students in California. This observation allows for the results of this study to be generalized to the overall human anatomy student population in California.

Recommendations

Recommendations for San Diego Miramar College

It is the firm belief of this researcher that affective educational objectives should be a curriculum development requisite at San Diego Miramar College. The results from this study support the notion that incorporating these learning objectives into a curriculum is an element that can be well received by students as well as pedagogically effective. It is likely that students who enroll in courses that include affective educational objectives, as opposed to exclusively cognitive objectives, will have a deeper and richer classroom experience.

This study introduced affective objectives vis-à-vis an art-science interdisciplinary lecture in a biology class. It would serve San Diego Miramar College well to consider if interdisciplinary teaching should be a regular component of curriculum development in other disciplines. Faculty need the time and resources to investigate this question. The college could recruit from its ranks faculty who are willing to investigate this matter further, and provide incentives such as release time from other campus duties. It is quite possible that small, pilot studies that emulate this project could yield similar results.

If this was to occur, the resulting ubiquitous nature of affective learning objectives in the curriculum would necessitate the inclusion of affective objectives in the assessment of previously developed curriculum as well as of current student performance. Perhaps exam questions that address the affective domain, but do not contribute to a student's grade but inform the instructor, could be regularly administered. Evaluating the affective domain for its own sake, as opposed to calculating a student's grade, is a goal that would point to the high value faculty and administration place on this important educational component.

Recommendations for Future Research

This dissertation focused on a very specific type of student and a very specific interdisciplinary complement: nursing and allied health pre-professionals in a human anatomy course who are exposed to an artistic and cultural vignette. Future research in the realm of interdisciplinary education and affective learning objectives should consist of studies with a variety of student populations, and with an array of interdisciplinary combinations. A study that employs liberal arts students could answer questions that were raised earlier in this chapter as it relates to generalizing the results of this study to other student populations. If interdisciplinary strategies were proven to be successful with a broad range of students across a wide range of disciplines, its acceptance in curriculum development would be more probable.

A project that is essentially the inverse of this study could also be instructive. Specifically, introducing anatomical images and discussing the scientific and cultural importance of the renderings in an art history or life drawing class, is the kind of study that would help determine if liberal arts students are receptive to this approach. It is probably safe to say that many students in the arts have a limited exposure to the sciences. Incorporating interdisciplinary modules into arts and humanities courses may prove to be the few exposures these students experience in their undergraduate studies. If these students are indeed responsive, which this researcher believes is likely to occur, the call for incorporating affective domain objectives across the arts and sciences curriculum would be all the more effective.

It could also be instructive to replicate this study, but with students who are pursing careers in related science areas (physical science, math, engineering). For example, a physics

course could employ modules that discuss the cultural influences that impeded research supporting theories that placed the sun, not the earth, at the center of solar system. Further, interdisciplinary combinations such as English and history, painting and chemistry, sculpture and geology, and geography and political science, are also appropriate possibilities. It should be noted that the underpinnings of all of the above projects should be directed towards enhancing the affective domain of the learning objectives for the primary course being studied.

One interesting finding of this study is that while the human anatomy course that was studied was an undergraduate class, the subjects themselves were not overwhelmingly undergraduate per se. As was stated earlier, Table 3 shows that 23% of the students had previously earned a bachelors degree or higher. It could be reasonably suggested that the significant affective domain response to the interdisciplinary intervention was a result of the academic maturity of these subjects. Conducting a study that attempts to control for age by including students who are between 18 and 22 years of age could answer this question by avoiding a skew that may have occurred in this study.

Educational level may be a predictor of a student's receptiveness to interdisciplinary education that is grounded in affective domain learning objectives. Although educational level was not identified as a statistically significant robust predictor of affective domain scores, it cannot be ignored that the students in this study were more educated than a typical undergraduate student. A study that attempts to control for educational level could more fully respond to questions about the relationship between educational level and the impact of interdisciplinary education on affective outcomes. In essence, both age and educational level are variables that warrant further research.

The students in this study also had a relatively high GPA; both genders were above 3.0 (Table 1). Furthermore, these students were pursuing a relatively rigorous science related course of study. As was stated in the previous chapter, examination of the data shows that 28% of the students in this study had already completed three or more biology classes. Interestingly, a closer look at the data reveals that 11% of the subjects had completed five or more biology classes. It should be noted that it is highly likely that these students had also completed significant coursework in chemistry, physics and calculus. It can be safely stated that the subjects in this study are academically successful in a challenging course of study. Future studies that examine students who are not so academically high achieving are worthy of consideration. A study with a very large sample size would be able to generate statistical models for students with lower grade point averages to determine if the affective domain of these students responded differently than students with higher grade point averages. This could be performed for science, as well as liberal arts students.

Future research could also address the very difficult question as to the relationship between the affective domain and its influence on cognitive outcomes. A study could investigate if students earned higher grades in classes that included affective educational objectives. Such projects, however, should be approached cautiously. To argue that affective outcomes are worthy of pursuit only if it results in enhanced cognitive outcomes is, in the mind of this researcher, a specious contention. Affective outcomes are valuable on their own merit, and are not required to be linked with cognitive achievement. Investigating the relationship between the two, however, seems appropriate as long as the results are not used to diminish the worth of the affective realm in educational objectives.

One limitation of this study is that the interdisciplinary intervention was only a one-hour vignette that was presented the first week of class. This cross-sectional approach provides only a "snap shot" of student responses to a brief interdisciplinary intervention. A future study that is longitudinal and therefore incorporates interdisciplinary strategies into the fabric of a class throughout an entire semester is likely to result in an even greater impact on the affective domain of students. A semester-long approach could be used as the foundation for the permanent inclusion of affective educational objectives in the curriculum via interdisciplinary education. It would also be more powerful to design a study that is more truly experimental via the element of subject randomization to control and experimental groups.

Another area of possible investigation is student attitudes towards professors who pursue affective learning outcomes via interdisciplinary education. If faculty are to petition for the inclusion of affective learning objectives in the curriculum, it would be instructive to ascertain the receptiveness of students towards this approach. Further, the attitude of faculty towards this type of teaching is another area of possible research. Gauging the willingness of faculty to incorporate interdisciplinary teaching for the pursuit of affective learning outcomes could inform strategies directed at modifying the curriculum process.

Finally, the development of a more precise and sensitive instrument for measuring changes in the affective domain is worthy of pursuit. There is a tension between the subtle and nuanced quality of affective learning outcomes and the blunt nature of questionnaires. It would be valuable to initially develop a comprehensive, semester long curriculum that directly addresses each category and subcategory of the affective domain. This could be accompanied by a comprehensive questionnaire that addresses each of these learning

objectives, and is administered several times throughout a semester. Further, a mixed methods research design that also includes qualitative data that is collected via interviews, and perhaps open-ended essay questions, may be especially effective at measuring subtle responses along the affective domain hierarchy. The above research design may be especially effective at discerning subtle changes at the fifth and highest category of the affective domain (Characterization by a value or value complex).

Concluding Remarks

This study provided new information in the arena of both interdisciplinary teaching and educational objectives in the affective domain. Findings reveal that human anatomy students positively respond to art-science interdisciplinary strategies that are geared toward enhancing the affective domain. Students seem to embrace this approach, as they responded in all components of the affective domain, and through a variety of demographic variables. This study answered some questions and raised others as it relates to the kind of student that is responsive in the affective realm to interdisciplinary approaches.

The results of this study will hopefully contribute to a growing body of knowledge that supports the supposition that affective educational objectives are a valid and valuable pedagogical element of curriculum design. It is the hope of this researcher that science and liberal arts educators alike will universally adopt these ideas. The ensuing paradigm could engender an educational experience where students go beyond mere course content. Ideally, students will be less likely to ask, "Do we need to know this for the next exam?" They may be more likely to ask complex questions that deal with attitudes, values and beliefs. Hopefully, as a consequence of a new curricular paradigm, students will gain an appreciation

for their studies that eclipses discipline content, develops higher levels of consciousness and mental complexity, and includes a deeper and richer worldview.

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Appendix A
Categories and Subdivisions of the Affective Taxonomy

Categories and Subdivisions of the Affective Taxonomy (Krathwohl et al., 1964)

1.0 Receiving (attending)

- 1.1 Awareness
- 1.2 Willingness to receive
- 1.3 Controlled or selected attention

2.0 Responding

- 2.1 Acquiescence in responding
- 2.2 Willingness to respond
- 2.3 Satisfaction in response

3.0 Valuing

- 3.1 Acceptance of a value
- 3.2 Preference for a value
- 3.3 Commitment (conviction)

4.0 Organization

- 4.1 Conceptualization of a value
- 4.2 Organization of a value system

5.0 Characterization by a value or value complex

- 5.1 Generalized set
- 5.2 Characterization

Appendix B
Informed Consent Form

Informed Consent Form

You are being asked to participate in a research project conducted by Kevin Petti, a doctoral candidate at the University of San Diego. The purpose of his research is to examine the effect of a certain type of teaching approach to human anatomy education on the attitudes and values of the student toward his or her studies. The results of this research could be helpful to science teachers as they evaluate and develop course curricula.

You will be asked to listen to an approximately one-hour presentation and view 15th and 16th century artistic renderings of human dissection scenes in European universities. You will then be asked to complete a questionnaire that asks you about how your attitudes toward anatomy education may have been influenced. The questionnaire will also contain demographic questions such as age, gender and previous college courses you may have completed. It should take you less than 30 minutes to complete the questionnaire.

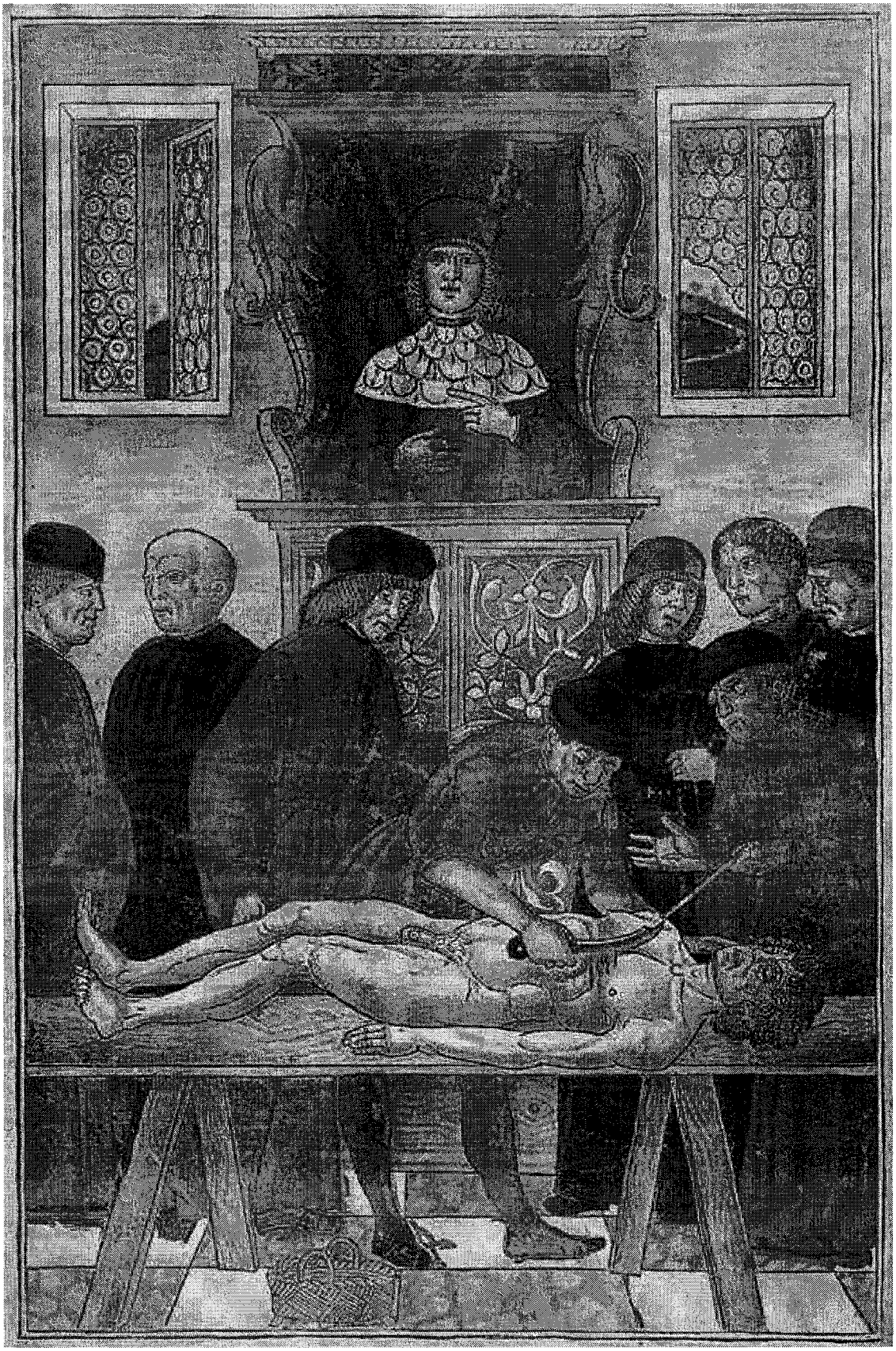
There are no health risks to this study. There is also no risk to your grade in this class being adversely affected no matter how you respond to the questionnaire or if you decide to not participate. Participation in this project is completely voluntary. You may withdraw your participation at any time and without penalty. While the results of this project may be published, your answers to the questionnaire are completely anonymous. Any information you provide will be identified only by number. Your questionnaire and consent from will remain in the sole possession of Kevin Petti who will be the only individual who will have access to them. Your questionnaire will be kept in a locked file cabinet for a minimum of five years before being destroyed.

Should you have any questions about this project, you can direct them to Kevin Petti at this time. Should you have any questions in the future, you can contact Kevin Petti at 619.388.7491, or his advisor at the University of San Diego, Dr. Fred Galloway, at 619.260.7435.

You will be given a copy of this form for your own records.

_____	_____
Signature of Subject	Signature of Investigator
_____	_____
Printed Name of Subject	Date
_____	
Date	

Appendix C
Image One
Mondino dei Liuzzi's *Anatomia,* in *Fasciculus Medicinae,* Johannes de Ketham, 1493



Appendix D
Image Two
Frontispiece to Andreas Vesalius' *Fabrica*, 1543

Appendix E
Interdisciplinary Module - Basic Lecture Outline

First Image

Frontispiece to *Fasciculus Medicinae* by Johannes de Ketham – 1493

1. A collection of texts and images from many authors
2. Ketham functioned as both author and editor
3. Highly successful for over 100 years
4. A founding text in human anatomy studies
5. Image introduces Mondino dei Liuzzi's *Anatomia* – 1316
6. The *Anatomia* was model for all anatomizing for over two centuries
7. This image is considered earliest rendering of an anatomy lesson and represents how anatomy was taught in late medieval and Renaissance Europe
8. Depicts Mondino himself presiding over anatomy lesson
9. Note the academic setting, how the *lector* sits in a *cathedra*, that he speaks in Latin and details the anatomy of Galen, a second century Greek whose anatomical and medical writings were considered dogma for 1500 years.
10. The *Anatomia* is fraught with errors due to its reliance on Galen
11. Human dissection was rare, and contributed to these errors due to cultural prohibitions
12. Galenic was therefore never challenged
13. Note the *ostensor* who interprets the Latin and points with a wand while the *sector* performs the dissection
14. Note the mediating role of the *ostensor* between *sector* and *lector*
15. Note the long academic regalia of all but the *sector*
16. The *sector* is a lower caste barber surgeon and neither professor or physician
17. Note that today physicians wear long robes and technicians wear short robes

Second Image

Frontispiece to Vesalius' *De Humani Corporis Fabrica* – 1543

1. Marks the beginning of modern science, greatest contribution to anatomizing, exquisite piece of creative art and bookmaking

2. Quintessentially Renaissance, elegantly blends art and science, note ornate columns, putti

3. *Fabrica* depicts progressively dissected men posing in countryside

4. *Fabrica* stands in start contrast with Mondino

5. Mondino's dissection is orderly, formal and private

6. Vesalius' is turbulent, public and almost theatrical

7. Vesalius descends from *cathedra* and conducts dissection himself, *sectors* displaced to under the table and argue over sharpening his tools

8. Animals, the foundation of Galenic anatomy are in periphery

9. Direction observation is central, as its placement on the page

10. This image further abounds with iconography

11. Many consider Vesalius at the least bold, and more so arrogant since he places himself center on the page and is the only to gaze at the viewer

12. Vesalius also surrounds himself with the giants of classical antiquity: Aristotle on the right (gazing back at animals) in the left foreground Galen and behind him Hippocrates

13. The presence of the greats marks their approval of Vesalius and makes him one of them

14. Unlike Mondino and Ketham, however Vesalius challenges Galen and these other ancients and represents the modern anatomy

15. Anatomy now evolves into a modern science

Appendix F
Justification of Affective Domain Questions in Krathwohl's Model

Educational Objectives - Krathwohl et al, 1964	Question to Student
1.0 Receiving (attending) 1.1 Awareness The learner will merely be conscious of something – that he take into account a situation, phenomenon, object or stage of affairs (pp. 176-177).	1. After today's lecture, I am now much more aware that human anatomy has a cultural, historical, and artistic heritage. 2. I was so interested in the topic being presented today that I listened attentively throughout the lecture.
1.2 Willingness to receive Attends (carefully) when others speak – in direct conversation…willing to tolerate a given stimulus, not to avoid it. (p. 177).	3. I am now more willing to attend lectures discussing the link between art and science.
1.3 Controlled or selective attention There is an element of the learner's controlling the attention here, so that the favored stimulus is selected and attended to despite competing and distracting stimuli. (p. 178).	4. I was so impressed with the images presented in the lecture that I hardly took my eyes off of them and I rarely found my mind wandering. 5. I am now more likely to look at images examining the relationship between art and science.
2.0 Responding 2.1 Acquiescence in responding There is the implication here that, should the conditions be such that other alternatives of response were open, and there were no pressures to conform with the teacher-held standard or social norm, the student might well choose an alternative response. (p. 119).	6. When I was informed that today's presentation would examine a link between art and science, I had no real feelings of resistance to listening to the lecture. 7. If I the opportunity to discuss another topic today, I very well many have been more interested in that. 8. Now that I have heard the lecture, I am more open to future discussions linking art with anatomy despite other options that may be before me.
2.2 Willingness to respond There is the implication that the learner is sufficiently committed to exhibiting the behavior that he does so not just because of a fear of punishment, but "on his own" voluntarily. (p. 179)	9. After today's lecture, I am now more likely to independently seek out and read books or articles as well as ask questions of my professors about the cultural, historical, and artistic aspects of human anatomy and other sciences as well.
2.3 Satisfaction in response …a feeling of satisfaction, an emotional response, generally of pleasure, zest or enjoyment. (p. 179).	10. I truly enjoyed today's lecture discussing the cultural, historical, and artistic aspects of human anatomy. 11. I am likely to take greater pleasure in further examination of this in my anatomy class as well as my other science classes.

Educational Objectives - Krathwohl et al, 1964	Question to Student
3.0 Valuing 3.1 Acceptance of a value ...the person is perceived by others as holding the belief or value. At the level we are describing here, he is both sufficiently consistent that others can identify the value and sufficiently committed that the he is willing to be so identified. (p. 141).	12. Today's presentation contained so much valuable information that I am now more likely to initiate conversations with my family and friends about how there is a strong connection between art and science.
3.2 Preference for a value Behavior at this level implies not just the acceptance of a value to the point of being willing to be identified with it, but the individual is sufficiently committed to the value to pursue it, to seek it out, to want it. (p. 145).	13. By virtue of today's presentation, I now place an extremely high value on the relationship between science and the humanities. 14. I am now more likely to read books and/or visit museum exhibits about the history of science.
3.3 Commitment The person who displays behavior at this level is clearly perceived as holding the value. He acts to further the thing valued in some way, to extend the possibility of his developing it, to deepen his involvement with it and with the things representing it. He tries to convince others and seeks converts to his cause. (p. 149)	15. I feel such commitment to the ideas presented in today's lecture that I will now share these ideas with my family and friends. 16. I will also attempt to convince my family and/or friends that science and art are strongly linked and that this concept is extremely important to understand and value.
4.0 Organization 4.1 Conceptualization of a value This permits the individual to see how the value relates to those he already holds or to new ones he is coming to hold. (p. 155). Many of the objectives which will be placed here may be worded in such a way that they appear to call for the comparative evaluation of values. (p. 156).	17. I found the symbolization in the images presented today to be fascinating. 18. By virtue of the presentation I am now likely to speculate what other meanings these symbols may have beyond the explanations presented in the lecture. 19. I am now more likely to form judgments as to how the meaning of these symbols represents the ethical or moral role of science in society.
4.2 Organization of a value system Objectives properly classified here are those which require the learner to bring together a complex of values, possible disparate values, and to bring these into an ordered relationship with one another...This is, of course the goal of such objectives, which seek to have the student formulate a philosophy of life. (p.159)	20. Today's lecture has changed my philosophy of higher education. 21. I now believe that all college classes, not just science classes, should be founded in an approach that examines relationships between the subject being primarily studied, and its connection with other disciplines.

Appendix G
Demographic Questions

Directions: Please answer each of the demographic questions to the best of your ability by circling the single answer that best describes you or writing the most accurate answer:

1. Your gender is:

Female Male

2. Your age in years is: _____

3. Which one of the below ethnicities do you most identify with as ethnically representing you?

American Indian African American Asian/Pacific Islander

Filipino Latino White

Other

4. Which if the following is the highest degree you have earned?

Less than High School Degree High School Diploma/GED Associate's

Bachelor's Degree Master's Degree Doctoral Degree

5. Which grade do you expect in this class?

A B C

D F Incomplete

Credit No Credit

6. Your college GPA is closest to which of the following?

≤1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9

2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9

3.0 3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8 3.9

4.0 No GPA since this is my first semester

7. Do you plan to work in the fields of either science or healthcare?

Yes No

8. Do you have parents, siblings or a spouse that presently works in the fields of science or healthcare?

Yes No

9. My father graduated from college with a minimum of a bachelor's degree?

Yes No Unsure

10. My mother graduated from college with a minimum of a bachelor's degree?

Yes No Unsure

11. How many college courses in biology have you completed?

0	1	2
3	4	5
6	7	8 or more

12. How many college courses in either art history or renaissance history have you completed?

0	1	2
3	4	5
6	7	8 or more

13. Do you believe that for your career it is important to have an understanding of the structure and function of the human body?

Yes No

14. Do you consider yourself to have a strong belief in God as the creator of humans?

Yes No

Appendix H
Affective Domain Questions

Directions: Please read each of the below questions carefully and circle the number that best represents your feelings towards the statement, with 1 meaning you Strongly Disagree, 4 meaning you are Neutral and 7 meaning you Strongly Agree. <u>The focus of these questions is to determine how much the lecture has changed, if at all, your thinking</u>.

1. After today's lecture, I am now much more aware that human anatomy has a cultural, historical, and artistic heritage.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

2. I was so very interested in the topic being presented today that I listened attentively throughout the lecture.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

3. I am now more willing to attend lectures discussing the link between art and science.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

4. I was so impressed with the images presented in the lecture that I hardly took my eyes off of them and I rarely found my mind wandering.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

5. I am now more likely to closely look at images examining the relationship between art and science.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

6. When I was informed that today's presentation would examine a link between art and science, I had no real feelings of resistance to listening to the lecture.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

7. If I had the opportunity to discuss another topic today, I very well may have been more interested in that.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

8. Now that I have heard this lecture, I am more open to future discussions linking art with anatomy despite other discussion choices that may be before me.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

9. After today's lecture, I am now more likely to independently seek out and read books or articles as well as ask questions of my professors about the cultural, historical, and artistic aspects of human anatomy and other sciences as well.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

10. I truly enjoyed today's lecture discussing the cultural, historical, and artistic aspects of human anatomy.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

11. I am likely to take great pleasure in further examination of this link between art, science and culture in my anatomy class as well as my other science classes.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

12. Today's presentation contained so much valuable information that I am now more likely to initiate conversations with my family and friends about how there is a strong connection between art and science.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

13. By virtue of today's presentation, I now place an extremely high value on the relationship between science and the humanities.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

14. I am now more likely to read books and/or visit museum exhibits about the history of science.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

15. I feel such commitment to the ideas presented in today's lecture that I will now share these ideas with my family and/or friends.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

16. I will also attempt to convince my family and/or friends that science and art are strongly linked and that this concept is extremely important to understand and value.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

17. I found the symbolization in the images presented today to be fascinating.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

18. By virtue of the presentation I am now likely to speculate what other meanings these symbols may have beyond the explanations presented in the lecture.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

19. I am likely to begin to form judgments as to how the meaning of these symbols represents the ethical or moral role of science in society.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

20. Today's lecture has changed my philosophy of higher education.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

21. I now believe that all college classes, not just science classes, should be founded in an approach that examines relationships between the subject being primarily studied, and its connection with other disciplines.

Strongly Disagree			Neutral			Strongly Agree
1	2	3	4	5	6	7

Appendix I

Letter of Authorization For This Project to be Conducted at Miramar College

San Diego Miramar College
10440 Black Mountain Road, San Diego, CA 92126-2999 (619) 388-7800

TO: Institutional Review Board, Office of the Provost, University of San Diego

FROM: Mary Beaird, Dean of Business, Math and Science, San Diego Miramar College

DATE: September 9, 2005

RE: Kevin Petti's Doctoral Dissertation Research at San Diego Miramar College

This memo is intended to inform the Institutional Review Board of the University of San Diego that San Diego Miramar College is aware that a member of our faculty, Kevin Petti, will be conducing research for his USD doctoral dissertation on our campus starting fall semester, 2005. We are fully aware that he will be administering a questionnaire to his students subsequent to a brief lecture addressing cultural and historical aspects of human anatomy. I have personally reviewed the questionnaire as well as the informed consent form he will be using.

Our institution is supportive of faculty conducting educational research with their students. It is our hope that this research will result in a more effective and enriching educational experience for the students attending our college.

If you have any questions, please feel free to contact me at: 619.388.7813

Appendix J
National Cancer Institute's Human Participant Protections Education Documentation

Completion Certificate

This is to certify that

Kevin Petti

has completed the **Human Participants Protection Education for Research Teams** online course, sponsored by the National Institutes of Health (NIH), on 09/09/2005.

This course included the following:

- key historical events and current issues that impact guidelines and legislation on human participant protection in research.
- ethical principles and guidelines that should assist in resolving the ethical issues inherent in the conduct of research with human participants.
- the use of key ethical principles and federal regulations to protect human participants at various stages in the research process.
- a description of guidelines for the protection of special populations in research.
- a definition of informed consent and components necessary for a valid consent.
- a description of the role of the IRB in the research process.
- the roles, responsibilities, and interactions of federal agencies, institutions, and researchers in conducting research with human participants.

National Institutes of Health
http://www.nih.gov