An Investigation of the Self-Efficacy of Medical Students for the Anatomy Curriculum: Role of Gender and Prior Experience, and Self-Efficacy's Influence on Academic Achievement

Jennifer Marie Burgoon

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Approved by:

Dr. Judith L. Meece, Chair

Dr. Diane M. Calleson

Dr. Noelle A. Granger

Dr. Jeffrey A. Greene

Dr. Wallace H. Hannum

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ABSTRACT

JENNIFER MARIE BURGOON: An Investigation of the Self-Efficacy of Medical Students for the Anatomy Curriculum: Role of Gender and Prior Experience, and Self-Efficacy's Influence on Academic Achievement
(Under the direction of Dr. Judith L. Meece)

Anatomical self-efficacy is defined as an individual's judgment of his or her ability to successfully complete tasks such as dissecting, learning anatomical knowledge, and applying anatomical knowledge to clinical situations. This research investigates medical student self-efficacy for the anatomy curriculum. Five surveys containing the same embedded anatomical self-efficacy instrument were completed by first-year medical students at the University of North Carolina School of Medicine; one pre-survey administered prior to students beginning a medial gross anatomy course and four post-surveys administered after students completed examinations during the course. Additional data collected included anatomical experiences prior to medical school, demographic information, MCAT scores, and anatomy exam scores, both written and laboratory practical. The results of the study indicated that when controlling for academic ability, the quantity of anatomical experiences prior to medical school predicted the anatomical self-efficacy of the students at the beginning of the medical anatomy course. However, when controlling for academic ability, prior anatomical experience alone did not predict self-efficacy at the end of the course. Secondly, although males and females were found to have the same quantity of anatomical experiences

prior to medical school, on average the female medical students had statistically significant lower anatomical self-efficacy at the beginning of the course than their male classmates, when controlling for academic ability. This difference in anatomical self-efficacy based on gender was found to be still present at the completion of the medical anatomy course. Next, when controlling for academic ability, the self-efficacy rating of each medical student at the beginning of the semester did not predict the final score the student obtained for the medical anatomy course. However, it was found that when controlling for academic ability, the self-efficacy ratings at the time of exam administrations predicted all four laboratory practical scores and two of the four written exam scores. Finally, results indicated that medical student anatomical self-efficacy increased during the course. Implications for anatomy instructors, medical students, and future research are discussed.

DEDICATION

To friends and family, especially my Dad, who passed away during my time in graduate school. You all are greatly missed.

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ABBREVIATIONS

AAMC	Association of American Medical Colleges
ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
E1	First Anatomy Exam - Composed of a Laboratory Practical Component and Written Examination Component – Covered Material on the Back and Upper Limb Regions of the Human Body
E2	Second Anatomy Exam - Composed of a Laboratory Practical Component and Written Examination Component – Covered Material on the Thorax and Abdominal Regions of the Human Body
E3	Third Anatomy Exam - Composed of a Laboratory Practical Component and Written Examination Component – Covered Material on the Pelvis and Lower Limb Regions of the Human Body
E4	Fourth Anatomy Exam - Composed of a Laboratory Practical Component and Written Examination Component – Covered Material on the Head and Neck Region of the Human Body
FIPSE	Fund for the Improvement of Postsecondary Education
GLM	General Linear Modeling
LP1	Laboratory Practical Component of First Anatomy Exam – Covered Material on the Back and Upper Limb Regions of the Human Body
LP2	Laboratory Practical Component of Second Anatomy Exam – Covered Material on the Thorax and Abdominal Regions of the Human Body
LP3	Laboratory Practical Component of Third Anatomy Exam – Covered Material on the Pelvis and Lower Limb Regions of the Human Body
LP4	Laboratory Practical Component of Fourth and Final Anatomy Exam – Covered Material on the Head and Neck Region of the Human Body
MCAT	Medical College Admission Test
MS1	First Year Medical Student Class

PAE	Prior (or Previous) Anatomical Experience
PAF	Principal Axis Factoring
PCA	Principal Component Analysis
SE	Self-Efficacy
UNC-SOM	University of North Carolina School of Medicine
WE1	Written Exam Component of First Anatomy Exam – Covered Material on the Back and Upper Limb Regions of the Human Body
WE2	Written Exam Component of Second Anatomy Exam – Covered Material on the Thorax and Abdominal Regions of the Human Body
WE3	Written Exam Component of Third Anatomy Exam – Covered Material on the Pelvis and Lower Limb Regions of the Human Body
WE4	Written Exam Component of Fourth and Final Anatomy Exam – Covered Material on the Head and Neck Region of the Human Body

CHAPTER 1

INTRODUCTION

Anatomy is the study of the body's structure. The word anatomy [*anatome* in Greek (Moore, 1992; Moore and Dalley, 1999)] is derived from two Greek words, the first being àvá which means 'apart' and the second being τέμνειν which means 'to cut' (Nancrede, 1904). The Education Affairs Committee of the American Association of Clinical Anatomists (1996) has stated that the human anatomy discipline is "the foundation of all medical knowledge" (p. 99), and, therefore, successful mastery learning of the gross anatomy curriculum in the medical school is vital to the development of a competent doctor (Cottam, 1999). A number of research projects have been conducted investigating predictors for medical gross anatomy success (Forester, McWhorter, & Cole, 2002; Peterson & Tucker, 2005) and medical school success (Dixon, 2004; Julian, 2005; Ramsbottom-Lucier, Johnson, & Elam, 1995). The research investigating predictive measures for success in medical anatomy coursework has focused primarily on the influence of undergraduate coursework (Forester et al., 2002; Peterson & Tucker, 2005). There has been no previous published research that has investigated student motivation for first year medical core courses and the influence that medical student motivation may have on academic achievement. Included in this lack of motivational research is the investigation of student self-efficacy for the medical gross anatomy curriculum and self-efficacy's predictive properties for that course.

Albert Bandura (1986) has defined perceived self-efficacy "as people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (p. 391). This perceived judgment influences people's behavior (e.g. achievement), choice in activities, persistence, effort, motivation, thoughts, and emotions (Bandura, 1986; Pintrich & Schunk, 2002). Therefore, within the context of the medical anatomy curriculum, perceived anatomical self-efficacy includes an individual's judgment of his or her ability to complete tasks such as dissecting, learning anatomical knowledge, and applying anatomical knowledge to clinical situations.

Over the last three decades, women have made major advances in higher education (Meece, 2006; Meece, Glienke, & Berg, 2006; Meece & Scantlebury, 2006). Women now earn more undergraduate college degrees than men (Meece et al., 2006; Meece & Scantlebury, 2006) and compose one half of all medical school enrollments in the United States (Association of American Medical Colleges [AAMC], 2007, 2008; Evans & Sarani, 2002; Halpern, 2006; U.S. Census, 2001; Wendel, Godellas, & Prinz, 2003), although at some medical schools women are the majority (Wendel et al., 2003). Even with these positive advances, many disparities between men and women still exist in terms of schooling experiences, employment, and wage gaps, especially as they pertain to science (Alexakos & Antoine, 2003; Graham & Smith, 2005, Halpern, 2006; Meece, 2006; Meece et al. 2006; Meece & Scantlebury, 2006). For example, although there has been a slight increase in the number of female surgical residents over past decade, male residents still drastically outnumber their female counterparts (Magrane, Lang, Alexander, Leadley, & Bongiovanni, 2007). In 2006, the percentages of female residents in particular surgical areas was as high as 31.0% in colon and rectal surgery, but as low as 11.5% in orthopaedic surgery (including

subspecialties) (Magrane et al., 2007). Another illustration of the disparities that exist in the sciences is seen in medical academia (Wright, Schwindt, Bassford, Reyna, Shisslak, St. Germain, & Reed, 2003). Although women are entering academic medicine careers in greater numbers, women continue to be outnumbered by men in academic medicine, hold fewer leadership roles, progress more slowly through the academic ranks, and earn 11% less than their male counterparts (Wright et al., 2003).

This particular study was conducted to investigate medical student self-efficacy for the anatomy curriculum. More specifically, the study examined the influence of anatomical experiences prior to medical school on anatomical self-efficacy of first year medical students, the influence of gender on anatomical self-efficacy and the level of anatomical experiences prior to medical school, changes in medical student anatomical self-efficacy over a medical gross anatomy course, and the influence of that anatomical self-efficacy on academic performance within a medical gross anatomy course.

Participating students were members of the first year medical student class (MS1) in the fall of 2004 at the University of North Carolina School of Medicine (UNC-SOM) who, as part of their first year medical school course work, completed a combined gross human anatomy, radiology, and embryology course entitled Human Anatomy and Embryology. In total, five surveys were completed by the participating 2004 UNC-SOM MS1 students; one pre-survey administered prior to beginning of the medical anatomy course and four post-surveys administered after students completed examinations in the course. All five surveys administered to MS1 participants contained the same embedded anatomical self-efficacy instrument, while the pre-survey also provided students with the opportunity to report information regarding their anatomical experiences prior to medical school and demographic

information. Additionally, if permission was granted, the MCAT scores and all anatomy exam scores (both written and laboratory practical) of participating students were obtained from the medical school registrar. A number of statistical analyses were performed on the data, including one-way analysis of variance (ANOVA), one-way repeated-measures analysis of variance (ANOVA), an analysis of covariance (ANCOVA), principal axis factoring (PAF), and hierarchical linear regressions using SPSS for Windows 11.5.0.

Using the anatomical self-efficacy ratings of the medical students obtained from the surveys, a number of results were found related to previous anatomical experiences prior to medical school, the effect of gender on anatomical self-efficacy, the influence of anatomical self-efficacy on academic achievement in a medical gross anatomy course, and changes in anatomical self-efficacy over a medical gross anatomy course. First, the quantity of anatomical experiences prior to medical school predicted the anatomical self-efficacy of the MS1 participants at the beginning of the course, when controlling for academic ability defined as the sum of students' scores obtained on the MCAT Physical Sciences section and the MCAT Biological Sciences section. However, when controlling for academic ability, prior anatomical experience alone did not predict self-efficacy at the end of the course. [It should be noted that there was an interaction between MCAT (which did predict the final self-efficacy) and prior anatomical experience such that there was a stronger relation between MCAT scores and final self-efficacy when students had a higher quantity of prior anatomical experience.] Secondly, although males and females were found to have the same quantity of anatomical experiences prior to medical school, on average the female medical students had statistically significant lower anatomical self-efficacy at the beginning of the course than did males, when controlling for academic ability. This difference in anatomical self-efficacy

based on gender was found to still exist at the completion of the Human Anatomy and Embryology course. Next, the self-efficacy ratings of the medical students at the beginning of the semester did not predict the final score obtained by the students for the Human Anatomy and Embryology course, when controlling for academic ability. However, the self-efficacy ratings obtained from the four post-surveys administered during the semester acquired different results in terms of predicting academic achievement. It was found that when controlling for academic ability, the self-efficacy ratings at the time of exam administrations predicted all four laboratory practical scores and two of the four written exam scores of the medical students. Finally, the statistical analyses conducted to determine how medical student self-efficacy for the anatomy curriculum changed during the semester indicated that the self-efficacy increased during the medical gross anatomy course.

This research project is the first to investigate anatomical self-efficacy of medical students. Therefore, the information obtained from this research project serves to contribute to the theory of self-efficacy and its research base by adding additional knowledge about the influence of gender and previous experience on self-efficacy, as well as about the predictive nature of self-efficacy for academic achievement, within a new curricular area and student population. Additionally, this research provides instructors of medical gross anatomy with insight into the motivation of their first year medical students. Motivational research, especially as it pertains to self-efficacy, has been limited in higher education (Bailey, 1999; Morris, 2004). However, its understanding is vital for the proper development of curriculum and learning environments so that student learning and academic achievement may be enhanced (Morris, 2004).

Medical schools, including the one at which this study is being conducted, do not require completion of an anatomy course prior to medical school admission. However, as previous research has illustrated the predictive nature of undergraduate anatomical curriculum completion on medical gross anatomy academic achievement (Forester et al., 2002; Peterson & Tucker, 2005) and the current research presented illustrates the predictive nature of previous anatomical experiences on the anatomical self-efficacy of medical students as they enter the gross anatomy curriculum, a re-examination of medical school admission requirements may be warranted once further research is conducted. Additionally, the results of this current research may provide insight into the causes behind fewer females than males choosing to practice surgery (Magrane et al., 2007), an area of medicine where anatomy is critical for mastery (Cottam, 1999). Thus, further anatomical self-efficacy studies should be conducted to investigate the anatomical self-efficacy of medical students during the fourth year of medical school when they select their medical specialty.

CHAPTER 2

BACKGROUND

Self-Efficacy Defined

Albert Bandura's social cognitive theory explains human functioning as the product of the reciprocal interactions between personal, behavioral, and environmental influences (Bandura, 1986; Pajares, 2002). In 1977, Bandura introduced a new and important piece to this social learning theory, namely the self-construct of self-efficacy (Bandura, 1977; Pajares, 2002). In his 1977 article, entitled *Self-Efficacy: Toward a Unifying Theory of Behavioral Change,* Bandura defined self-efficacy (or what he also referred to then as efficacy expectations) as "the conviction that one can successfully execute the behavior required to produce the outcomes" (p. 193). This and similar definitions of self-efficacy can be found in Table 1.1. Of those definitions given in Table 1, the most fundamental definition is from Schunk (1991), who defines self-efficacy as "an individual's judgements of his or her capabilities to perform given actions" (p. 71). In other words, perceived self-efficacy is the personal judgment a person makes about his or her own capabilities or abilities to successfully perform a task (Schunk, 1991). When a person has high self-efficacy, the individual perceives that they have the skills to succeed at a task and when a person has low self-efficacy, the individual perceives that they do not have the skills to succeed at a task. Therefore, within the context of the anatomy curriculum, perceived anatomical self-efficacy would include an individual's judgment of his or her ability to complete tasks such as

dissecting, learning anatomical knowledge, and applying anatomical knowledge to clinical situations. Self-efficacy is a self-perception of capability (Morris, 2004) and is considered task, situation, or domain specific (Pajares, 1996; *Self-efficacy: How it differs from self-concept*, retrieved January 26, 2003).

Table 1.1 Definitions of Self-Efficacy from the Literature

Definition	Source
"An efficacy expectation is the conviction that one can successfully execute the behavior required to produce the outcomes" (p. 193).	Bandura (1977)
"Perceived self-efficacy is defined as people's judgements of their capabilities to organize and execute courses of action required to attain designated types of performances" (p. 391).	Bandura (1986)
"An individual's judgements of his or her capabilities to perform given actions" (p. 207)	Schunk (1991)
"Perceived self-efficacy is defined as people's beliefs about their capabilities to produced designated levels of performance that exercise influence over events that affect their lives" (p. 71).	Bandura (1994)
"Self-efficacy is a belief about what one is capable of doing; it is not the same as knowing what to do" (p. 108).	Schunk (2000)
"Self-efficacy is a context-specific assessment of competence to perform a specific task or a range of tasks in a given domain – an individual's judgement of his or her capabilities to perform given actions."	*Self-efficacy: How it differs from self-concept*, (retrieved January 26, 2003)

This table shows a number of the definitions of self-efficacy from the literature over the years since it was first introduced by Bandura in his 1977 article entitled *Self-Efficacy: Toward a Unifying Theory of Behavioral Change.* In the 1977 article, Bandura also referred to self-efficacy as efficacy expectations.

Self-Efficacy Dimensions

Efficacy expectations are said to vary in magnitude or level, strength, and generality

dimensions (Bandura, 1977, 1986; Zimmerman, 2000). The magnitude or level characteristic of self-efficacy refers to the dependence self-efficacy has to the level of task or domain difficulty (Bandura, 1977, 1986; Zimmerman, 2000). For a task's domain, an individual's level of self-efficacy can extend from simple tasks to the most difficult tasks or it may only be associated with the simplest of tasks (Bandura, 1977, 1986). In other words, as a certain task domain becomes more difficult, people may begin to lose their self-efficacy for that task. Zimmerman (2000) provides the example of the spelling domain when words increase in difficulty. As the words being spelled increase in difficulty (i.e. difficulty as it pertains to being able to correctly spell the word), the amount of self-efficacy can decrease or not extend to those more difficult words. For example, an individual's self-efficacy for being able to spell *cat* may not be extended to the spelling of *supercalifragilistic-expialidocious*, believed by an individual to be a more difficult word to spell.

The strength dimensions for self-efficacy refers to an individual's certainty about being able to perform a task or skill (Zimmerman, 2000). A weak [in terms of strength (e.g. weak or strong), not directionality (e.g. high or low)] self-efficacy is easily stifled by a disconfirming outcome, while a strong self-efficacy will not be diminished by a few disconfirming outcomes or failures (Bandura, 1977).

As for generality, this refers to the transferability of self-efficacy from one activity to another (Zimmerman, 2000). This dimension of self-efficacy remains a debated and hot topic in research (Bong & Clark, 1999; Pajares, 1996; *Self-efficacy: Future directions in self-efficacy research*, retrieved January 26, 2003), as past research on the topic of self-efficacy's generality has been limited (Bong, 1997). A study by Bong (1997) investigated the subject of academic self-efficacy generality in high school students. For the study, students were

shown Scholastic Aptitude Test (SAT) questions on English, Spanish, U.S. history, algebra, geometry, and chemistry and then asked to judge their perceived capability to correctly solve each problem. They were also shown additional questions on arithmetic progression (algebra) and/or constant acceleration (physics), since they were isomorphic problems (i.e. where knowledge of one principle could be used to solve problems of another area), and asked to rate their perceived capability to successfully solve these problems. The results of Bong's 1997 study showed a support for the generality of academic self-efficacy beyond the bounds of a specific task and, to a lesser degree, school subject.

Influence of Self-Efficacy

Self-efficacy is a factor that plays into student motivation and has been found to influence a number of academic behaviors (Schunk, 1984, 1991). Of particular interest to this study is the positive correlation observed between self-efficacy and academic achievement (Lent, Brown, and Larkin, 1984; Multon, Brown, & Lent, 1991; Pajares, 1996; Pintrich & DeGroot, 1990; Schunk, 1995; Schunk & Pajares, 2002). An example of this predictive property of self-efficacy for academic achievement was studied by Pintrich and DeGroot (1990) in seventh graders enrolled in science and English classes. Pintrich and DeGroot showed that higher levels of self-efficacy were associated with higher levels of student achievement in terms of grades, seatwork, reports, essays, exams, and quizzes. Although most often studied at the primary and secondary schooling level, the capability of self-efficacy to predict academic achievement has also been demonstrated at the collegiate level (Cavallo, Potter, & Rozman, 2004).

Self-efficacy has also been found to influence student motivation in a number of areas other than academic achievement. It has been found to influence a person's choice in

activities (Bandura, 1986, 1994; Zimmerman, 2000). Those individuals with high self-efficacy have been found to be more eager to participate in challenging tasks and set higher goals (Bandura, 1994). If an individual has low self-efficacy for a particular task, they are likely to avoid that task (Bandura, 1986, 1994; Pintrich & Schunk, 2002). Next, self-efficacy has been found to influence the effort an individual puts forth in two dimensions: 1) the amount of effort put forward; and 2) the rate of performance (Zimmerman, 2000). Those with high self-efficacy will work harder and perform tasks more quickly than those with low self-efficacy (Zimmerman, 2000).

Self-efficacy can further influence a person's motivation in terms of persistence. This influence on persistence is particularly important in the face of obstacles and difficult tasks, since a person with high self-efficacy will persist in the face of these obstacles and difficult tasks (Bandura, 1986; Schunk & Pajares, 2002). This is in contrast to a person with low self-efficacy, as they will not persist and will give up quickly in the face of obstacles (Bandura, 1994).

Finally, self-efficacy can influence a person's thought patterns and feelings (Bandura, 1986; Pajares, 2002). Those with low self-efficacy believe the related activities are harder than they really are, which can lead to stress, anxiety, and/or depression (Bandura, 1986; Pajares, 2002).

Self-Efficacy versus Other Constructs and Personal Expectancies

There are several personal expectancies or self-constructs that are often compared to or used interchangeably with self-efficacy (Bong & Clark, 1999; Schunk, 1991; Zimmerman, 2000). Although there may be some similarities, these differ conceptually and psychometrically from self-efficacy (Zimmerman, 2000). In this section, the differences and

similarities between self-efficacy and outcome expectations, self-concept, self-confidence and self-esteem are discussed, along with further explanations of the influence of self-efficacy.

Self-Efficacy vs. Response-Outcome Expectations. According to Bandura (1977), efficacy expectations are not the same as response-outcome expectations. Self-efficacy or efficacy outcomes are the beliefs the individual has about his or her ability to produce certain outcomes, while outcome expectations are what an individual estimates as possible outcomes or consequences that will result from certain behaviors (Bandura, 1977, 1986; Schunk, 2000). Bandura (1977) presented his theory concerning how efficacy expectations and response-outcome expectations differ in a diagram. Efficacy expectations, in Bandura's (1977) model, are present at the initiation level of the action or behavior unlike outcome expectations. Therefore, if a person does not believe that he or she has the personal mastery skills to complete a task (i.e. low self-efficacy), the individual can avoid the task or behavior. This means that self-efficacy influences an individual's choice of behaviors and/or activities (Bandura, 1977; Schunk, 1991). This efficacy can also affect the effort and persistence of the behavior once it is initiated, even in the face of obstacles and adversity (Bandura, 1977; Schunk, 1991). Conversely, according to Bandura (1977), outcome expectations have little to no influential effect on behavior. This is because, according to Bandura (1986), "expected outcomes are [so] highly dependent on self-efficacy judgements that expected outcomes may not add much on their own to the prediction of behavior" (p. 392-393). Simply stated, outcome expectations are, in part, determined by efficacy beliefs (Pajares, 1996). Most individuals that judge themselves as highly efficacious also expect favorable or positive outcomes, while those individuals that judge themselves as low in efficacy will predict

unfavorable or negative outcomes (Bandura, 1986). However, Pajares (1996) and Pintrich and Schunk (2002) make the point that self-efficacy and expectation outcome beliefs are not always positively correlated, as it is possible for a student to have high self-efficacy, but negative outcome expectations or vice versa.

The difference between self-efficacy and outcome expectations was investigated by Shell, Murphy, and Bruning (1989) (Zimmerman, 2000). In the Shell et al. study, researchers investigated graduate student reading and writing achievement and the effects that self-efficacy and outcome expectancy had on that performance. The authors found that self-efficacy and outcome expectancy together explained approximately 32% of the reading performance variance. However, self-efficacy alone accounted for almost 28% of the variance. Additionally, self-efficacy alone played a role in explaining approximately 10% of the writing performance variance among the students (i.e. outcome expectancy was not a statistically significant contributor to the variance seen in writing performance). The results of Shell et al. agree with Bandura's (1986) predictions, that achievement or performance is more strongly related to self-efficacy rather than to outcome expectations (Shell et al., 1986; Zimmerman, 2000).

How can this difference between self-efficacy and response-outcome expectations play out in the academic setting? Schunk (2000) makes the point that "students may believe that a positive outcome will result from certain actions but also believe that they lack the competence to produce those actions" (p. 108). This can be explained further through the following hypothetical situation. Bill, a first year medical student, believes that by passing his final practical exam in human gross anatomy he will receive a high grade for the semester, gain the respect of his instructors, and better his chances for placement into a

highly respected residency program (i.e. Bill has high outcome expectations). However, Bill does not believe that he possesses the study skills needed to prepare for the exam and he does not feel efficacious about his ability to master anatomical knowledge or skills (i.e. Bill has low self-efficacy for his study habits and his mastery of anatomical knowledge and skills). Therefore, although Bill studies for the exam, his effort and persistence when studying and preparing are low. Additionally, when Bill takes the exam he skips questions and his effort is minimal. As a result, Bill fails the exam. [For similar examples, see Bandura (1986) p. 392 and Schunk (2000) p. 108.]

Self-Efficacy vs. Self-Concept. Although they are closely related, the self-constructs of self-efficacy and self-concept are different (Bong & Clark, 1999; Zimmerman, 2000). The definition of self-concept (and occasionally self-efficacy) varies widely (Bong & Clark, 1999), a confusion that has led some researchers to use the two self-constructs interchangeably (Bong & Clark, 1999; Pajares, 1996). Bandura (1986) defined self-concept as "a composite view of oneself that is formed through direct experience and evaluations adopted from significant others" (p. 409). Similarly, a web page that discusses how self-efficacy is different from self-concept has defined self-concept as "a cognitive appraisal, integrated across various dimensions, that individuals attribute to themselves, typically accompanied by self-evaluative judgement of self-worth (self-esteem)" [*Self-efficacy: How it differs from self-concept*, retrieved January 26, 2003]. Additionally, according to Shavelson, Hubner, and Stanton (1976), there are seven features of self-concept. Shavelson et al. (1976) state that "self-concept may be described as: organized, multifaceted, hierarchical, stable, developmental, evaluative, [and] differentiable" (p. 411).

Self-efficacy and self-concept differ in a number of ways. The first difference between the two self-constructs is that self-efficacy is domain, task, or context specific, while self-concept is more global (Bong & Clark, 1999; Pajares, 1996; Pintrich & Schunk, 2002). However, Pajares (1996) makes the point that self-concepts do have the potential to be domain specific, but they are never task specific like self-efficacy. A person usually has a general, overarching self-concept or self-perception that can be further divided into academic and non-academic self-concepts (Shavelson et al., 1976). The academic self-concept can be further divided into subareas of self-concept or subject matter areas such as English, history, math, and science (Shavelson et al., 1976). Therefore, it would be possible for someone to have low self-efficacy about passing an anatomy practical, but have a high self-concept in academics. The opposite (i.e. high self-efficacy and low self-concept) is possible as well (Pajares, 1996).

Another difference between self-concept and self-efficacy is the weight or value given to social comparisons by individuals when they are assessing their self-concept or self-efficacy (Bong & Clark, 1999). Self-concept is based heavily on the social comparisons that one makes to others, while self-efficacy is heavily based on personal past-experiences or accomplishments (Bong & Clark, 1999) (see *Sources of Information Used to Form Self-Efficacy Judgments* section below). Self-efficacy can also be based on social comparisons (also known as vicarious experiences), however these are not as influential as personal performance accomplishments (Bandura, 1977, 1986). Vicarious experiences are typically used when accessing self-efficacy when an individual lacks any relevant personal experiences on which to base their evaluations of potential capabilities (Bandura, 1986, 1997; Bong & Clark, 1999; Gredler, 1997).

Bong and Clark (1999) present a comparison of academic self-efficacy and self-concepts through a review of the theoretical or conceptual framework, empirical evidence, and research methodology. One interesting difference outlined by the article was the difference in the underlying composition or conceptualization of self-efficacy and self-concept. According to the authors, there has been discussion of self-concept as a reflection or incorporation of both cognitive and affective responses. For example, a cognitive facet of self-concept is when an individual collects and processes self-information such as awareness and attributes, and forms evaluations of himself or herself. The affective facet of self-concept is the feelings tied to that acquired personal information and self-evaluations, feelings that are developed through comparison to others. On the other hand, the authors state that self-efficacy is mainly a result of cognitive processes or perceptions (i.e. competence assessments) and does not necessarily include affective reactions when being conceptualized. [For further discussion, see Bong and Clark (1999).]

The self-constructs of self-concept and self-efficacy are also similar. One important way that the constructs are similar is that both constructs can be used to help predict or explain academic motivation and achievement (Bong & Clark, 1999; Pajares, 1996). Interestingly, self-efficacy beliefs are considered to be one aspect of self that are used in the cognitive development of self-concept (Bong & Clark, 1999; Pajares, 1996; Schunk, 1991), which has lead to problems in distinguishing between the two in research (Bong & Clark, 1999).

Self-Efficacy vs. Self-Confidence. Self-confidence is defined by Schunk (1991) as "an individual's belief that he or she has the ability to produce results, accomplish goals, or perform tasks competently" (p. 211). Self-confidence, like self-efficacy, is a component of

self-concept (Schunk, 1991). However, self-efficacy and self-confidence are not the same. Bandura (1997) makes an interesting comparison between the two constructs. He states that confidence can be more of a general or nondescript term, while self-efficacy needs to refer to a specific task. In fact, Bandura (1997) calls confidence not a construct, but a catchword used widely in sports.

Self-Efficacy vs. Self-Esteem. Although they have been used interchangeably, self-efficacy and self-esteem are two very different constructs (Bandura, 1997). However, self-efficacy and self-esteem are both underlying constructs or dimensions of self-concept (Schunk, 1991). "Self-esteem typically refers to one's general feelings of self-worth, in which the self is treated as a global entity" (Bong & Clark, 1999, p. 141). Self-esteem is a question of whether an individual respects him or herself (Schunk, 1991). Therefore, the major difference between self-efficacy and self-esteem is that self-efficacy are judgements or perceptions of personal capabilities, while self-esteem are judgements or perceptions of self-worth (Bandura, 1997).

Sources of Information Used to Form Self-Efficacy Judgments

Constructing one's own self-efficacy is a cognitive process which integrates information (Hampton, 1998) of varying influence and derived from a variety of sources (Bandura, 1977, 1986). Albert Bandura (1977, 1986) theorized that self-efficacy beliefs are acquired through four main sources of information, namely: 1) personal performance accomplishments (also called enactive attainment or mastery experiences); 2) vicarious or observational experiences; 3) social verbal persuasion; and 4) physiological and emotional states. It is important to note that these four sources are not inherent, but must be cognitively processed to gain value in constructing self-efficacy (Hampton, 1998).

Personal performance accomplishments or mastery experiences. An individual's own authentic accomplishments, successes, and mastery experiences provide the most reliable and influential information for accessing self-efficacy (Bandura, 1977, 1986, 1994, 1995, 1997; Schunk, 1991, 2004). Generally, personal successes raise perceived personal self-efficacy (Bandura, 1977, 1986, 1994, 1995, 1997; Schunk, 1991, 2004) by informing the individual that they possess and can utilize the skills needed to be successful at a specific task (Bandura, 1995, 1997). However, if successes come too easily, an individual's self-efficacy can be easily undermined when they ultimately face a difficult task riddled with obstacles (Bandura, 1994, 1995, 1997). Instead, self-efficacy is best rooted in mastery accomplishments that are achieved by the individual overcoming obstacles and difficulties with persistent effort (Bandura, 1994, 1995, 1997). Not only do such personal accomplishments increase the performance or mastery abilities of the individual in that particular area, they can also develop or increase general skills such as coping (Bandura, 1977) and other tools that can be used when facing new situations (Bandura, 1995, 1997). Once self-efficacy is enhanced through personal performance accomplishments, it can transfer or generalize to other related situations (Bandura, 1977, 1986).

Personal failures generally tend to lower self-efficacy (Bandura, 1977, 1986, 1994; Schunk, 1991, 2004), but the influence of failures on perceived self-efficacy depends upon the timing of those failures and on past experiences (Bandura, 1977). In fact, sometimes personal failures can have little or no effect on perceived self-efficacy (Bandura, 1977). For example, if an individual succeeds at a certain activity most of the time and a strong positive self-efficacy is established, one failure may not significantly decrease their self-efficacy

(Bandura, 1977, 1986; Schunk, 1991, 2004). However, if failure occurs before self-efficacy is firmly established, self-efficacy can be easily weakened (Bandura, 1994, 1995).

When looking at the influence of personal accomplishments on self-beliefs, a relation is observed between Weiner's attribution theory and Bandura's self-efficacy construct. Bernard Weiner's attribution theory (Weiner 1974, 1979, 1985a, 1985b, 1986, 1992; Weiner, Frieze, Kukla, Reed, Rest, & Rosenbaum, 1971) considers: 1) how individuals understand and feel about their own success or failure at such things as learning, performance, and goal achievement; and 2) how those understandings and feelings influence future actions (i.e. behavior), such as continuing and enhancing motivation (Driscoll, 2000). [For more information on Weiner's attribution theory, see Weiner 1974, 1979, 1985a, 1985b, 1986, 1992 and Weiner et al. 1971.] When an individual succeeds or fails at a task, the attribution(s) or perceived cause(s) an individual assigns for that outcome is one clue used to judge self-efficacy for that task (Schunk, 1991). In other words, how an individual attributes an outcome, namely as the result of the level of effort and/or the difficulty of the task, will influence their self-efficacy for that task (Schunk, 1991; Bandura, 1997). For example, if a student passes an anatomy exam because they believed that the exam was easy, their self-efficacy would not be increased as much as it would if they passed an anatomy exam they perceived as difficult (Schunk, 1991). Typically, when failing individuals assign causal attributions for their failure, those with low self-efficacy are likely to attribute failures to a personal lack in abilities, while those with high self-efficacy likely attribute their failures to a lack of effort (Bandura, 1986).

According to Bandura (1997), the effect of effort attributions on self-efficacy is dependent on how that individual perceives the reason for having to exert high (or even low)

effort. For example, consider a student that receives a very high grade on an anatomy exam and attributes their high grade to high effort. If the student believes that they had to exert a large amount of effort to achieve the high grade because they have low ability, their self-efficacy could decrease. However, if the student believes that having to put forth a high effort simply enhanced their already good abilities (i.e. by mastering the anatomy information and exam), then their self-efficacy could increase. [For more on how effort expenditure influences self-efficacy, see Bandura 1997.]

Vicarious or observational experiences. Vicarious experiences by observation of social models (Bandura, 1994) are a source of information that are not as dependable as personal performance accomplishments (Bandura, 1977, 1986). However, vicarious experiences are influential pieces of information when an individual lacks any relevant personal experiences on which to base an evaluation of their own potential capabilities (Bandura, 1986, 1997; Bong & Clark, 1999; Gredler, 1997). An individual's self-efficacy can be raised when they see others whom they consider similar to themselves succeed at difficult tasks through sustained effort (Bandura, 1977, 1994) and, thus, avoid the adverse consequences of failure (Bandura, 1977). Seeing models succeed makes an individual believe that they too possess the ability to succeed (Bandura, 1986, 1994; Schunk, 2004). The observer's self-efficacy increases not only from seeing others like themselves succeed, but also by acquiring knowledge, skills, and strategies from the models for their own use (Bandura, 1986, 1994).

A number of factors are involved for vicarious or observational experiences to influence self-efficacy. For an observation to have an effective influence on self-efficacy, the individual must first see himself or herself as similar to the model (Bandura, 1994).

Second, for the transmittal of efficacy information, the outcomes must be clear to the observer (Bandura, 1977). Finally, the more people the individual sees succeed at a task, the more information is transmitted to the observer (Bandura, 1977). Bandura (1977) stated this occurs because "if people of widely differing characteristics can succeed, then observers have a reasonable basis for increasing their own sense of self-efficacy" (p. 197). However, self-efficacy enhanced by vicarious experiences can be easily lost through subsequent personal failures (Schunk, 1991).

It should be pointed out that self-efficacy can also be decreased through observations of social models (Bandura, 1994; Schunk, 2004). If an individual observes models similar to themselves fail at a task despite high effort, the observer's self-efficacy may decrease (Bandura, 1986, 1994).

Social verbal persuasion. Social verbal persuasion, or the suggestion by others that an individual can succeed, as a source of information to judge one's self-efficacy, is not as effective as personal accomplishments (Bandura, 1977). An individual can be verbally persuaded that they possess the skills and characteristics needed to succeed, even though they may have failed in the past (Bandura, 1977). This, in turn, can provide an enhancement in self-efficacy that can help them to increase their effort and persistence (Bandura, 1986, 1994). However, self-efficacy based on verbal persuasion is only temporary and can be easily extinguished when a failure occurs due to difficult obstacles and a long history of past failures exists (Bandura, 1977; Schunk, 1991). Moreover, with additional failures, self-efficacy can be further undermined and the persuader(s) can be discredited (Bandura, 1977, 1986). As Bandura (1986) noted, "it is probably more difficult to produce enduring increases in perceived efficacy by persuasory means than to undermine it" (p. 400).

Psychological and emotional states or indices. Individuals can gain information about their ability to perform a task through changes and feedback in psychological and emotional states (Bandura, 1977, 1986, 1994; Schunk 1991, 2004). Depending on how they perceive and interpret the changes in psychological and emotional states (Bandura, 1994), some individuals may associate increases in sweating and heart rate as signs of their lack of ability (Schunk, 1991). When individuals are more anxious, they generally see it as a sign of vulnerability (Bandura, 1986, 1994). Additionally, Bandura (1986) points out that "by conjuring up fear-provoking thoughts about their ineptitude, people can rouse themselves to elevated levels of distress that produce the very dysfunctions they fear" (p. 401).

Gender, Science, and Self-Efficacy

National and international studies of industrial countries such as the United States have found that overall, females perform higher on literacy (i.e. reading and writing) achievement tests, while males perform higher on math and science achievement tests (Halpern, 2006; Meece & Scantlebury, 2006). Due to the focus on gender equity in schools over the past few decades, the achievement gap in mathematics appears to be shrinking, although the gender gap in science achievement continues to persist (Meece & Scantlebury, 2006). The difference between the males and females in science becomes more pronounced as children age (Halpern, 2006) and, relative to females, males show gains in natural sciences from fourth to twelfth grade (Halpern, 2006; Willingham & Cole, 1997).

Of interest for this study is the discrepancy between male and female achievement in science. The reasons for these varying achievements are multifold and an area of continued contention and debate politically, socially, and scientifically. Higher science achievement for males is influenced by a number of factors, such as males' advantage in using visuospatial

information (Halpern, 2006) and spatial transformation (Halpern, 2006; S.C. Levine, Huttenlocher, Taylor, & Langrock, 1999), brain differences (Halpern, 2006), and parent engagement with their children in informal science activities (Crowley, Callanan, Tenenbaum, & Allen, 2001). A critical influence in the discrepancy between male and female achievement in science is due to the reinforcement of stereotypical traditional gender roles by primary and secondary schools (Meece et al., 2006; Meece & Scantlebury, 2006). This reinforcement by schools occurs through multiple avenues including the mode of classroom instruction (Halpern, 2006; Meece et al., 2006; Meece & Scantlebury, 2006), the structure of assessment tools (Halpern, 2006), staffing patterns, curricular materials such as textbooks, and classroom interaction patterns (Meece et al., 2006; Meece & Scantlebury, 2006).

This reinforcement of the stereotypical roles of males and females in schools and in the general culture has the potential to influence thoughts, performance, and academic motivation (Halpern, 2006; Meece et al., 2006; Meece & Scantlebury, 2006). Gender differences in competency perceptions that follow stereotypic lines (i.e. females are better at literacy and writing, while males are better at mathematics and science) are already present by early elementary school (Eccles, Barber, Jozefowicz, Malenchuk, & Vita, 1999; Eccles, Wigfield, Harold, & Blumenfeld, 1993; Meece et al., 2006; Meece & Scantlebury, 2006). Gender differences in self-efficacy beliefs also follow along these same stereotypic lines, as males report higher self-efficacy than females in science (Anderman & Young, 1994; Meece et al., 2006; Tippins, 1991) and math (Junge & Dretzke, 1995; Meece et al., 2006), while females report higher self-efficacy than males for writing (Meece et al., 2006; Pajares & Valiante, 1997, 2001). Although gender differences in self-efficacy have been studied

principally at the primary and secondary level, the same gender discrepancies in science (Cavallo et al., 2004) and math (Betz & Hackett, 1983) self-efficacy have also been demonstrated at the collegiate level.

Computer technology has become a critical part of the anatomical curriculum in medical schools, as well as in daily medical profession activities. Therefore, it is important to mention gender differences in technology in terms of access, confidence, self-efficacy, and interest. Although males and females appear to have equal interests in computers during primary schooling (Meece & Scantlebury, 2006), by secondary schooling more males than females enroll in computer courses (Meece & Scantlebury, 2006; S. M. Smith, 2005). The research of Sax, Astin, Korn, and Mahoney (2001) found that females entering their freshman year of college in the fall of 2000 felt less confident than their male classmates about their computer abilities (Ching, Basham, & Jang, 2005). Another study found that male undergraduate students had higher computer self-efficacy than females for beginning skills and file/software management skills (S. M. Smith, 2005). Research has shown that males have had more access and exposure to computers than females both in the home and at school (Furger, 1998; Mayer-Smith, Pedretti, & Woodrow, 2000; Sutton, 1991). Thus, there is a 'digital divide' that has been created between males and females (Ching et al., 2005; Cooper & Weaver, 2003; Meece & Scantlebury, 2006), although recent studies indicate that this digital divide between genders may be disappearing (Imhof, Vollmeyer, & Beierlein, 2007; Price, 2006). Despite recent progress to bridge the divide, the majority of today's medical students grew up in the 1980's (and soon the 1990's) when the digital divide was most prevalent and, thus, have the "harshest legacy of the digital divide" (Ching et al., 2005, p. 394). However, gender differences in terms of computer technology do not need to be an

issue in technology-rich classrooms, such as science classrooms, if a proper classroom environment is established and sound pedagogical practices are followed (Mayer-Smith et al., 2000).

Medical Anatomical Instruction: Dissection, Current Shifts, and Predictors for Success

From the 15th to the late 20th centuries, cadaver dissection had stood alone as the primary resource with which medical students explored and learned about the structure of the human body (Ellis, 2001; Persaud, 1984, 1997). In 1996, the Educational Affairs Committee of the American Association of Clinical Anatomists stated that the anatomy discipline remains "the foundation of all medical knowledge" (p. 99). However, the status quo in anatomy instruction (i.e. dissection) has been dramatically affected and challenged with the recent advances in technological capabilities.

Information technologies, especially the personal computer, have created a significant shift in teaching practices in all areas and levels of education, with the instruction of human anatomy in the medical school being no different (M.G. Levine, Stempak, Conyers, & Walters, 1999; Marks, 2000; Ritt & Stewart, 1996; Walsh & Bohn, 1990). There has been extensive debate concerning what role computer instruction should take in an anatomy curriculum (Ellis, 2001; Marks, 1996). D.G. Jones (1997) states that anatomy instruction would be best served by the combination of informational technology and the continued use of cadaver dissection.

Advances in information technology are not the only catalysts for shifts in anatomy instruction. There has been a significant decrease in the time allotted to instruction in gross anatomy in the medical curriculum (Cottam, 1999; Dyer & Thorndike, 2000; Marks, 1996; Leong, 1999), mainly due to the explosion of additional scientific knowledge (Dinsmore,

Daugherty, & Zeitz, 1999; Leong, 1999) and other disciplines into the medical curriculum (Bouchet, 1996; Granger, 2004). When looking at the number of contact hours allotted to the instruction of gross anatomy (i.e. lecture time plus laboratory time) in a standard medical curriculum during the twentieth century, the contact time dropped dramatically from 549 hours in 1902 to 330 hours by 1955 and continued to drop to 225 hours by 1997 (Dyer & Thorndike, 2000). A 1999 report by M.G. Levine et al. stated that the national average of contact hours in gross anatomy was 182. Along those same lines, Harvard Medical School's New Pathology held only 180 hours of anatomy instruction in 1999, of which only 48 hours were devoted to laboratory time (Dyer & Thorndike, 2000). It should also be noted that there is an inadequately low number of faculty available to provide medical students direction in the anatomy laboratory (M.G. Levine et al., 1999), due to the retirement of a generation of older anatomists and the abolishment of programs to train new ones (Erkonen, Krachmer, Cassell, Albanese, & Stanford, 1992; Granger, 2004).

Predictors for medical student success in the gross anatomy curriculum have been addressed by studies conducted by Forester et al. (2002) and Peterson and Tucker (2005). Both studies investigated the role of premedical coursework as predictors of medical gross anatomy performance. Forest et al. found that students with premedical gross anatomy and/or histology [i.e. a subdiscipline of anatomy that studies the microscopic structure of tissues (Tortora & Derrickson, 2006)] earned significantly more points in corresponding medical courses than those lacking those same premedical coursework experiences. In the Forrest et al. study, those students that completed premedical histology coursework earned an average of 12.7 more points in a 480-point medical histology course than their classmates with no histology premedical course, while those students that completed a premedical gross

anatomy course earned an average of 19.9 more points in an 800-point medical gross anatomy course than their classmates with no premedical gross anatomy course. Although the difference was not significant, Forest et al. also noted that the average number of points earned by the medical students who had completed a premedical gross anatomy course with a lab was higher than those that had completed a premedical gross anatomy course without a lab. Peterson and Tucker found similar results for a 172-hour medical anatomy course, except instead of correlating the prior coursework with points earned in the medical anatomy course, they looked at class rank in the medical anatomy course and the score earned on the comprehensive final examination. However, as mentioned earlier, no studies have investigated the role motivation plays in predicting medical anatomy curricular success. Therefore, this study was conducted to investigate a new potential predictor of medical anatomy curriculum success, namely self-efficacy.

Research Questions and Hypotheses

The study conducted addressed the following questions and allowed the testing of several hypotheses about medical student self-efficacy for the anatomy curriculum made prior to the completion of all statistical analyses.

Question 1: Regardless of prior experiences, gender, and academic ability, how does medical student self-efficacy for the anatomy curriculum change during the semester? As mentioned earlier, personal performance accomplishments are the most reliable and influential information for accessing self-efficacy (Bandura, 1977, 1986, 1994, 1995, 1997; Schunk, 1991, 2004). As medical students begin an anatomy course, most will be presented with new anatomical challenges. On average, it is believed that these anatomical experiences will be positive and, therefore, should positively influence student anatomical self-efficacy.

As the semester continues, these challenges will become somewhat repetitive with the only major difference being the region of the body studied.

There are two regions of the body that have a strong potential to negatively influence self-efficacy, namely the pelvic region (studied weeks 7 and 8 of the semester) and the head and neck (studied during week 11 through week 15 of the semester) region. Students generally have a difficult time completing the dissection of the pelvis and visualizing the 3-dimentional relationships of pelvic structures. The study of the head and neck region requires minute and tedious dissections, as well as the understanding and learning of difficult concepts such as cranial nerve passage through the skull.

First year medical students will be well informed of these pelvic and head and neck obstacles by the second year medical students. However, this potential for a decrease in medical student self-efficacy for the anatomy curriculum due to social verbal persuasion should be negated by the development of positive self-efficacy through mastery experiences earlier in the semester and through positive vicarious experiences, as the first year students realize that second year medical students similar to themselves passed this portion of the course just a year earlier.

Therefore, based on the information presented above, it is hypothesized that medical student self-efficacy for the anatomy curriculum will change during the semester. Specifically, it is hypothesized that student anatomical self-efficacy will increase significantly at the beginning of the semester and then remain unchanged.

Question 2: Do anatomical self-efficacy ratings predict measures of academic performance (i.e. laboratory practical scores and/or written exam scores) in the medical gross anatomy course, when controlling for academic ability? As mentioned earlier, student

motivation and achievement studies have shown a positive correlation between self-efficacy and academic achievement (Lent et al., 1984; Multon et al., 1991; Pajares, 1996; Pintrich & DeGroot, 1990; Schunk, 1995; Schunk & Pajares, 2002). The positive predictive property of self-efficacy for academic achievement has been observed in the primary and secondary schools (Pintrich & DeGroot, 1990), as well as at the undergraduate post-secondary education level (Cavallo et al., 2004). Although medical students are typically older than those students participating in past student motivation and achievement studies, it is hypothesized that the anatomical self-efficacy of the medical students will predict the scores on both the laboratory practical and written exam components when controlling for academic ability.

Question 3: Does a medical student's self-efficacy for the anatomy curriculum at the beginning of the semester predict a student's final score for the course, when controlling for academic ability? As mentioned earlier, self-efficacy has been found to influence a person's choice in activities (Bandura, 1994), the effort an individual puts forth in two dimensions (i.e. the amount of effort and the rate of performance) (Zimmerman, 2000), and persistence when facing of obstacles and difficult tasks (Bandura, 1986; Schunk & Pajares, 2002). Therefore, it is hypothesized that those students with higher self-efficacy at the beginning of the course will have a higher final score for the course than their classmates with lower initial self-efficacy for the anatomy curriculum, when controlling for academic ability.

Question 4: When controlling for academic ability, can differences in self-efficacy at the beginning of the medical gross anatomy course be explained by the quantity of prior anatomical experiences? As mentioned earlier, personal performance accomplishments are the most reliable and influential information for accessing self-efficacy (Bandura, 1977,

1986, 1994, 1995, 1997; Schunk, 1991, 2004). Therefore, it is hypothesized that those medical students with higher levels of previous anatomical experiences prior to medical school will have higher self-efficacy for the anatomy curriculum, even with academic ability taken into account.

Question 5: Are there gender differences in the quantity of previous anatomical experiences? Most medical schools, including the one at which this study was conducted, do not require completion of an anatomy course prior to medical school admission. Therefore, any anatomical experiences prior to medical school could reflect a student's interest in and accessibility to the subject area. As females generally have lower self-efficacy for science (Anderman & Young, 1994; Meece et al., 2006; Tippins, 1991) and because lower self-efficacy can influence a person's choice in activities (Bandura, 1994), it is conceivable that female medical students will have fewer opportunities than their male classmates for mastery experiences in science curriculums, such as anatomy, prior to medical school. The intent of males to take more elective science classes than females has been demonstrated, for example, during high school (Tippins, 1991). Therefore, it is hypothesized that the female medical students will have fewer previous anatomical experiences prior to medical school than their male counterparts.

Question 6: When controlling for academic ability, are there gender differences in self-efficacy at the beginning of the medical gross anatomy course? It is hypothesized that the gender differences in science self-efficacy that develop during primary and secondary schooling will still be prevalent at this level and, therefore, female medical students will exhibit a lower self-efficacy than their male counterparts. This difference will be partially influenced by the females missing opportunities that allow them to gain positive anatomical

mastery experiences prior to medical school. Males, on the other hand, will accept these opportunities for mastery experiences in anatomy. As mentioned earlier, it is these mastery experiences that provide the most reliable and influential information for accessing self-efficacy (Bandura, 1977, 1986, 1994, 1995, 1997; Schunk, 1991, 2004).

Question 7: If they do exist, do differences in self-efficacy due to gender and/or previous experiences still exist at the end of the semester, when controlling for academic ability? Self-efficacy has been found to influence a person's choice in activities (Bandura, 1986, 1994; Zimmerman, 2000). Those individuals with high self-efficacy have been found to be more eager to participate in challenging tasks and set higher goals (Bandura, 1994), while those individuals with low self-efficacy are likely to avoid tasks (Bandura, 1986, 1994; Pintrich & Schunk, 2002). Therefore, as the semester progresses, it is hypothesized that female students and those students with lower previous anatomical experiences will continue to have lower self-efficacy for the anatomy curriculum than the male students and those with higher previous anatomical experiences.

Significance and Need for Study

The study of student self-efficacy and its influence has been conducted chiefly at the primary and secondary education levels (i.e. K-12), leaving a significant gap in the self-efficacy research at the postsecondary education level (Bailey, 1999; Morris, 2004), that is, in terms of undergraduate and graduate students, college/university faculty, and college/university administrators (Morris, 2004). This gap in research includes medical student self-efficacy. For those few studies that have investigated medical student self-efficacy, they have typically concentrated on the students' beliefs in terms of future interactions with patients, thus leaving the medical school core curriculum unexplored. For

example, one study investigated medical student self-efficacy in relation to student perceptions of their abilities to screen for risk factors and to council patients on modifying their risky behaviors (Pololi, Potter, & Garber, 1998). Therefore, this study was conducted to begin the investigation of medical student self-efficacy in the area of the anatomy curriculum.

The anatomy curriculum has been selected for this study because a solid understanding of human anatomy during the first year of medical school is the key to success in subsequent years of training and the development of an effective and knowledgeable doctor. In 1999, Cottam published an article that reported the results of a residency program survey. Of those U.S. residency programs that responded to the survey (n = 801), 86% reported that they believed solid knowledge of gross anatomy was extremely important or very important. Additionally, 57% of the residency programs reported that their incoming residents needed a refresher course in anatomy, while 14% reported that their incoming residents were seriously deficient in anatomical knowledge. With the importance of anatomy to medicine, a better understanding of student motivation in this academic discipline is essential for proper curriculum development and its execution in the medical school.

Most medical schools, including the one at which this study is being conducted, do not require completion of an anatomy course prior to medical school admission. Therefore, any anatomical experiences prior to medical school should be a reflection of the student's interest in and accessibility to the subject area. Additionally, medical students come to medical school with varying undergraduate degrees. For example, the participants for this proposed study hold undergraduate degrees from areas such as biology, chemistry, public health, women's studies, English, business administration, theater, and psychology. Thus,

these students are entering medical school from varying backgrounds and have varying exposure to mastery experiences in scientific curriculums, such as anatomy. Therefore, information obtained from this study could be vital for the proper selection of pre-requisites for medical students, especially when one considers that the major factor influencing self-efficacy is prior experience (Bandura, 1977, 1986, 1994, 1995, 1997; Schunk, 1991, 2004).

CHAPTER 3

METHODS

Student Participation in Study

Participating students were members of the 2004 first year medical student class (MS1) at the University of North Carolina School of Medicine (UNC-SOM), a class which is state mandated not to exceed 160 students. The 2004 MS1 students were asked to participate in an overarching study funded by an U.S. Department of Education Fund for the Improvement of Postsecondary Education (FIPSE) Grant entitled *Web-Based Materials for the Enhancement of Anatomical Instruction in the Health Sciences*[1], which included this described research on self-efficacy. Students were recruited to participate at a technology orientation session held prior to beginning all medical school coursework. At these technology sessions, 157 MS1 students consented to participate in the study and completed the pre-survey, along with a consent form that requested permission to use and/or obtain all student survey data, MCAT scores, and all anatomy exam scores (i.e. written and practical) for the project.

Human Anatomy and Embryology Course

As part of their first year medical school course work, the 2004 MS1 completed a combined gross human anatomy, radiology, and embryology course, entitled Human

[1] Grant (P116B010181) from the U.S. Department of Education, Fund for the Improvement of Postsecondary Education (FIPSE) to Noelle A. Granger, Ph.D. and O.W. Henson, Ph.D., Department of Cell and Developmental Biology, UNC-SOM.

Anatomy and Embryology, from mid-August to mid-December. This course included 39.5 hours dedicated to lecture and 90 hours dedicated to dissection (Fisher-Neenan & Davis, n.d.). Due to space allocation issues, students were placed into dissection groups of eight, allowing half the students (i.e. four) to dissect every other laboratory period.

Survey Administration

Surveys were administered to the 2004 MS1 students at the UNC-SOM. This survey was administered as part of the U.S. Department of Education Fund for the Improvement of Postsecondary Education (FIPSE) Grant *Web-Based Materials for the Enhancement of Anatomical Instruction in the Health Sciences*.

In total, five surveys were completed by the 2004 UNC-SOM MS1 students; one pre-survey and four post-surveys. (See Table 2.1 for the calendar dates of each survey administration.) The pre-survey was administered six days prior to the beginning of the Human Anatomy and Embryology Course, as part of the technology orientation sessions for first year medical students. The first three post-surveys (i.e. post-survey 1, post-survey 2, and post-survey 3) were administered during the first Human Anatomy and Embryology class period following each examination, while the final post-survey (i.e. post-survey 4) was completed by the students immediately following the completion of the final exam for the course. Post-survey 1 was administered following the first examination in the course, an examination that tested student knowledge of the back and upper limb regions of the body. Post-survey 2 was administered following the second examination in the course, an examination that tested student knowledge of the thoracic and abdominal regions of the body. Post-survey 3 was administered following the third examination in the course, an examination that tested student knowledge of the pelvic and lower limb regions of the body.

Post-survey 4 was administered following the fourth and final examination in the course, an examination that tested student knowledge of the head and neck region of the body. All survey data were entered into Microsoft® Access 2002 and converted to SPSS for Windows 11.5.0 using DBMS/COPY for Windows 7.0.6.

Table 2.1 Survey and Exam Administration Schedule

Survey	Date of Survey Administration	Related Exam	Topics of Related Exam	Date of Related Exam Administration
Pre-Survey	08/11/04	N/A	N/A	N/A
Post-Survey 1	09/09/04	Exam 1	Back and Upper Limb	09/07/04
Post-Survey 2	09/28/04	Exam 2	Thorax and Abdomen	09/27/04
Post-Survey 3	11/02/04	Exam 3	Pelvis and Lower Limb	11/01/04
Post-Survey 4	12/06/04	Exam 4	Head and Neck	12/06/04

This table lists the schedule of survey and anatomy exam administration to MS1 students at UNC-SOM in the fall of 2004. Each post-survey was administered following the completion of an exam. Also, included in the table, are the body regions covered on each exam. [Note: The pre-survey was administered prior to start of classes for the first year medical students. The Human Anatomy and Embryology course began on 08/17/04.]

Cleaning of Data

Certain participants were automatically removed from the entire study if they met any of the following criteria:

1) The participant did not give permission for their MCAT and/or anatomy exam scores to be released from the registrar's office.

2) The participant did not complete the course (i.e. they withdrew from the course prior to the end of the semester).

Other participants were dropped from individual analyses based on certain criteria (ex. did not report gender). These will be further discussed in the description of each analysis conducted.

Univariate normality of the continuous data, specifically the quantity of prior anatomical experience, MCAT scores, lab practical scores, written exam scores, end of the course score, and self-efficacy ratings at each time point for both the original reported self-efficacy and the factor score representing self-efficacy obtained through principal axis factoring, was investigated by calculating and examining the skewness and kurtosis statistics prior to beginning all analyses.

Demographics of Participants

Demographic data on student participants were obtained through survey questions posed as part of the pre-survey. After participants were removed based on the automatic criteria listed above, descriptive statistic analyses were conducted to provide demographic characteristics of the sample population in the areas of age, gender, ethnicity, and MCAT score. Age of the MS1 participants was calculated as of August 1, 2004.

Self-Efficacy Instrument and Principal Axis Factoring

All five surveys administered to MS1 participants contained the same embedded anatomical self-efficacy instrument. This instrument consisted of 16 anatomical self-efficacy items (see Figure 2.1), based on the college biological literacy self-efficacy instrument for non-majors described by the Baldwin, Ebert-May, and Burns (1999). The self-efficacy items gave students Likert scale response options: 1—*if you are NOT AT ALL confident that you*

SELF-CONFIDENCE/SELF-EFFICACY--*Please CIRCLE the number that applies.*

The answers to these questions can be the following:

1—If you are **not at all** confident that you can do the task.
2—If you are **only a little** confident that you can do the task.
3—If you are **fairly** confident that you can do the task.
4—If you are **very** confident that you can do the task.
5—If you are **totally** confident that you can do the task.

	Not at All	Only a Little	Fairly	Very	Totally
1) I am confident that I can make the proper cuts in the cadaver as outlined in the lab manual.	1	2	3	4	5
2) I am confident that I can successfully answer questions from the professors **during dissection laboratories**.	1	2	3	4	5
3) I am confident that I can use dissection tools.	1	2	3	4	5
4) I am confident that I can successfully complete the dissections.	1	2	3	4	5
5) I am confident that I can correctly pronounce anatomical terms.	1	2	3	4	5
6) I am confident that I can learn anatomical relationships (i.e. how one item relates to another in position in the body).	1	2	3	4	5
7) I am confident that I can learn anatomical terms and definitions.	1	2	3	4	5
8) I am confident that I can perform successfully on the anatomy course **written** exams.	1	2	3	4	5
9) I am confident that I can perform successfully on the anatomy course **lab practical** exams.	1	2	3	4	5
10) I am confident that I will be able to retain and recall anatomical knowledge **for use in a clinical setting**.	1	2	3	4	5
11) I am confident that I can actively participate in anatomical discussions **with the professors in the dissection laboratories**.	1	2	3	4	5
12) I am confident that I can locate anatomical structures in the human cadaver.	1	2	3	4	5
13) I am confident that I can identify anatomical abnormalities in the human cadaver.	1	2	3	4	5
14) I am confident that I can describe anatomical structures to a **non-medical** person.	1	2	3	4	5
15) I am confident that I can successfully answer **anatomical-based** questions **during clinical rotations**.	1	2	3	4	5
16) I am confident that I can learn the anatomical content of this anatomy course.	1	2	3	4	5

Figure 2.1 Instrument to Measure Anatomical Self-Efficacy. This self-efficacy instrument was incorporated into a larger survey administered as part of a FIPSE study awarded to the UNC-SOM. The statements in the instrument was based on the Biology Self-Efficacy Scale developed by Baldwin et al. (1999) to measure the self-efficacy of undergraduate non-biology majors for biology.

can do the task; 2—*if you are ONLY A LITTLE confident that you can do the task*; 3—*if you are FAIRLY confident that you can do the task*; 4—*if you are VERY confident that you can do the task*; and 5—*if you are TOTALLY confident that you can do the task*.

Principal axis factoring (PAF), also known as common factor analyses, of the 16 self-efficacy survey items was used to investigate how well these variables related to one another and to produce factor scores to be used as the self-efficacy rating of each student at particular time points throughout the semester. PAF was selected rather than other factor analysis procedures as PAF analyzes the data in a way that is more consistent with the theory that there is something in the student's mind called self-efficacy that is influencing the way they respond to the items. This is different from other factoring analyses such as principal component analysis (PCA) where one accepts that all survey items combine to produce some kind of phenomenon such as socioeconomic status (SES). Additionally, PAF searches for the least number of factors which account for only the common variance (i.e. correlation) between a set of variables, while PCA accounts for both the common variance and unique variance (Garson, 2008).

PAF was conducted five times, once for each survey administration. When conducting the PAF, extracted factors were of interest when their eigenvalues were 1 or higher. Additionally, when interpreting the factor loadings, any variable that presented a loading of .3 or higher on a factor was retained. Finally, the factor scores for the factors with eigenvalues over 1 were retained and the factor scores for the factor identified as self-efficacy was used as the self-efficacy rating for the student at the corresponding time point during the semester.

At all five time points, students needed to respond to at least 75% (or 12) of the self-

efficacy items to be included in the self-efficacy analyses related to that particular time point. For those students who completed at least 75% of the self-efficacy items at a particular time point, any missing data was substituted with the average of the remaining items completed by the student at that respective time point.

Because factor analysis creates factor(s) scores that are standardized with a mean of zero, any repeated measure analyses will require the use of the original self-efficacy data. Therefore, for any repeated measure analyses, the self-efficacy for a particular time point will be the average of the student reports on the 16 self-efficacy items. Again, students need to respond to at least 75% (or 12) of the self-efficacy items at a particular time point to be included in any related self-efficacy analyses. For those students who completed at least 75% of the self-efficacy items at a particular time point, any missing data was substituted with the average of the remaining items completed by the student at that respective time point.

Coefficient Alpha

Once it was determined which self-efficacy items to retain for the factor identified as self-efficacy through principal axis factoring, the internal reliability of the employed scale was investigated at each survey administration point. To investigate the internal reliability of the self-efficacy scale, coefficient alpha was calculated at each survey administration point.

Prior Anatomical Experience

The survey provided students the opportunity to report information regarding their anatomical experiences prior to medical school (see Figure 2.2). Students reported whether they had completed a human anatomy course prior to medical school, a non-human anatomy

BACKGROUND INFORMATION --*Please CIRCLE the number that applies.*

1. Have you had a **human** anatomy course prior to this semester?
   1 ----- Yes
   2 ----- No

2. Have you had any type of anatomy course **other than human** prior to this semester?
   1 ----- Yes
   2 ----- No

3. Please indicate the type(s) of **dissection** experience you have had and when it occurred. **If you have had no prior dissection experience, please check here _____ and skip to #4.** [Dissection experience means you performed the dissection yourself (i.e. "hands on").]

			After Undergraduate for:	
	High School or Earlier	**During Undergraduate**	**Graduate Work**	**Work/ Job**
Human	1	2	3	4
Other Vertebrates	1	2	3	4
Invertebrates	1	2	3	4

4. Please indicate the type(s) of **prosection** experience you have had and when it occurred. **If you have had no prior prosection experience, please check here _____ and skip to #5.** [Prosection experience means that another individual performed the actual dissection and you observed the final result.]

			After Undergraduate for:	
	High School or Earlier	**During Undergraduate**	**Graduate Work**	**Work/ Job**
Human	1	2	3	4
Other Vertebrates	1	2	3	4
Invertebrates	1	2	3	4

5. Have you ever **used an anatomy website** for educational purposes?
   1 ----- Yes
   2 ----- No

Figure 2.2 Portion of Pre-Survey to Determine Prior Anatomical Experience. This portion of the pre-survey was included to allow students to self-report anatomical experience prior to medical school. A positive reply to any of these items was counted as one point and all points were added to determine a final anatomical experience level for each student. A student could have a total anatomical experience level between 0 and 27.

course prior to medical school, completed dissections of human and/or non-human vertebrates and/or invertebrates during high school or earlier, undergraduate, graduate school, and/or a job, and, finally, if they had ever used an anatomical website for educational purposes. A positive reply to any of these items counted as one point and all points were

added to determine a final total previous anatomical experience level, with a potential minimum of 0 and a potential maximum of 27. This prior anatomical experience level indicated only the quantity of anatomical experiences in anatomy prior to medical school and did not reflect the quality and/or type of anatomical experience.

MCAT Scores

The consent form students completed at the time of the pre-survey included a request to obtain and use their Medical College Admission Test (MCAT) scores. If permission was granted, the MCAT scores were obtained from the medical school registrar's office. This information was provided in a Microsoft® Excel spreadsheet and converted to SPSS for Windows 11.5.0 using DBMS/COPY for Windows 7.0.6.

MCAT scores were requested for use as a control for student academic ability in a number of analyses. Academic ability for each student was defined by the sum of the student's scores obtained on the MCAT Physical Sciences section and the MCAT Biological Sciences section.

According to the Association of American Medical Colleges (2005), the MCAT serves "to assess mastery of basic concepts in biology, chemistry, and physics, to evaluate facility with problem solving and critical thinking, to assess communication/writing skills, [and] to help [medical] admission committees predict which applicants will perform successfully in the medical school curriculum" (p.1). The MCAT exam serves as a predictor for academic success in medical school, as MCAT scores have been shown to predict medical school grades and the United States Medical Licensing Examination (USMLE) Step 1, 2, and 3 scores (Julian, 2005). The predictive nature of physical MCAT and biological MCAT scores has also been demonstrated in relation to performance on the Comprehensive

Osteopathic Medical Licensing Examination-USA (COMLEX-USA) and GPA attainment in Osteopathic Medicine Schools (Dixon, 2004).

The MCAT is a standardized test that consists of three multiple choice sections (i.e. physical sciences, biological sciences, and verbal reasoning), as well as a writing section (Association of American Medical Colleges, 2005). Of interest to this particular study are the physical sciences and biological sciences sections. The MCAT Physical Sciences section accesses the understanding basic concepts and reasoning skills in the areas of chemistry and physics, including information such as solubility, acid/bases, and partial pressure (Association of American Medical Colleges, 2005), which are a number of key concepts for an understanding of body homeostasis. The MCAT Biological Sciences section accesses the understanding of basic concepts and reasoning skills in biology and biologically related areas within chemistry (Association of American Medical Colleges, 2005). The MCAT Biological Sciences section assesses many biological areas including an understanding of the human body systems' physiology, as well as some anatomy (Association of American Medical Colleges, 2005). Therefore, the MCAT sciences scores serve not only a predictor for academic success in medical school, but also as an index of prior knowledge in the sciences, including anatomy.

MCAT scores were requested for use as a control for student academic ability in a number of analyses for two reasons. The first reason is because the research design is not random but a non-randomized convenience sampling, as only medical students who were first year medical students at the UNC-SOM were asked to participate in the study. The second reason that MCAT is being used as a control is that these students have varying academic abilities and prior knowledge. As this study is investigating the role of prior lab

experience and gender have on self-efficacy, as well as the role self-efficacy has on the course academic outcomes, alternative hypotheses need to be ruled out. Therefore, the MCAT sciences scores (calculated by summing the scores the students obtained on the MCAT Physical Sciences section and the MCAT Biological Sciences section) will be referred to as "academic ability" and will represent the potential of students to succeed in medical school, as well as their prior knowledge in the biological sciences which includes anatomy.

Anatomy Course Exam Scores

The students completed four in-class exams (see Table 2.1) as part of the Human Anatomy and Embryology course. Each exam included a written multiple-choice question component (worth 50%) and a lab practical component (worth 50%) (Fisher-Neenan & Davis, n.d.). Each component (i.e. the written and the lab practical) was worth 100 points, with the final score for the exam obtained by averaging the two components. These four total exam scores were then weighted in computing the final grade for the Human Anatomy and Embryology course: 20% for exam 1, 25% for exam 2, 25% for exam 3, and 30% for exam 4 (Fisher-Neenan & Davis, n.d.). The written component's multiple-choice questions required students to demonstrate anatomical knowledge in terms of classical relationships, imaging (e.g. x-rays, MRIs, and CTs), embryology, function, general terminology, and clinical correlations. The laboratory component consisted of fill-in-the-blank identifications on labeled cadavers, models, skeletons, and images (e.g. x-rays, MRIs, CTs, and embryological). The laboratory practical questions were timed, with the students limited to one minute per question. Each component (i.e. the written and the lab practical) was worth 100 points, with the final score for the exam obtained by averaging the two components.

For this self-efficacy investigation, both the written exam scores and the lab practical scores at each time point were used as variables. Additionally, the final score the students achieved for the overall Human Anatomy and Embryology course was used as a variable and needed to be calculated. To calculate the final course grade, the exam score at each of the four exam administration time point was needed. Each exam score was calculated by combining the written multiple-choice question component (worth 50%) and the lab practical component (worth 50%), as was the procedure for the course (Fisher-Neenan & Davis, n.d.). Then, to produce the final course grade, the four exam grades were weighted in computing the final grade: 20% for exam 1, 25% for exam 2, 25% for exam 3, and 30% for exam 4, as was the procedure for the course (Fisher-Neenan & Davis, n.d.).

The consent form students completed at the time of the pre-survey included a request to obtain and use their and anatomy course exam scores, both the written exam scores and laboratory practical scores. If permission was granted, the anatomy course exam scores were obtained from the medical school registrar's office. This information was provided in a Microsoft® Excel spreadsheet and converted to SPSS for Windows 11.5.0 using DBMS/COPY for Windows 7.0.6.

Analyses to Address Research Questions

With the data cleaned and additional variables calculated, the following analyses were conducted to address each of the research questions. For each of the analyses, significance was set at ≤ 0.05, unless otherwise specified.

Question 1: Regardless of prior experiences, gender, and academic ability, how does medical student self-efficacy for the anatomy curriculum change during the semester? Potential changes in self-efficacy between consecutive time points (i.e. survey

administrations; five in total) were investigated by using one-way repeated-measures analysis of variance (ANOVA). No controls were used for this investigation. Only those participants that completed at least 75% of all five surveys were retained for this analysis, and as this is a repeated measures analysis the original self-efficacy data was used instead of the results of PAF. In other words, the self-efficacy rating at each particular time point was obtained through the average of the 16 self-efficacy survey items. If a main effect is found, pairwise comparisons using paired-samples *t*-tests were conducted to asses which self-efficacy means are different from each other, as well as estimating effect size using Cohen's *d*. The significance level for the main effect is $p \leq .05$, while the significance level for the pairwise comparisons will be $p \leq .005$ as determined using the Bonferroni correction (i.e. .05/10 contrasts).

Question 2: Do anatomical self-efficacy ratings predict measures of academic performance (i.e. laboratory practical scores and/or written exam scores) in the medical gross anatomy course, when controlling for academic ability? Students completed four exams (E1, E2, E3, and E4) during the semester that included both a laboratory practical component (LP1, LP2, LP3, and LP4) and a written exam component (WE1, WE2, WE3, and WE4). At or near each of these exam administrations throughout the semester, the students also completed a post-survey, which provided a self-efficacy rating, through factor analysis, at each respective examination point [i.e. self-efficacy as reported by post-survey 1 at E1, self-efficacy as reported by post-survey 2 at E2, self-efficacy as reported by post-survey 3 at E3, and self-efficacy as reported by post-survey 4 at E4].

To investigate a possible relation between anatomical self-efficacy and academic performance at each of the four exam administration points, hierarchical linear regression

analyses were conducted. During these analyses, academic ability, defined as defined by the sum of the physical sciences and biological sciences MCAT scores, was controlled as MCAT scores have been shown to predict medical school grades (Julian, 2005). The equation being investigated is:

$$\text{score} = b_0 + b_1\text{MCAT} + b_2\text{SE} + b_3\text{MCAT*SE}$$

The potential predictive nature of self-efficacy for academic performance was investigated twice at each exam point. The laboratory practical and written scores were analyzed separately instead of combining the scores, as was done during the course to produce a final score for each exam administration. The two scores at each exam point were analyzed separately because of the Pearson product-moment correlation coefficients computed between the laboratory practicals and written exam scores at each of the four examination time points (see Tables 2.2a-d). The correlation coefficients between the written exam portion and laboratory exam portion at each time point ranged from .66 to .70 and each was statistically significant at the .01 level. In general, these results suggest that if a student did well on the written portion of the exam, they did well on the laboratory practical portion of the exam. However, these correlation coefficients reflected at most 49.4% shared variability, indicating that although the two portions did relate, each portion of the exam still accessed some different aspects of anatomical knowledge and understanding in a particular region of the body. Therefore, the potential predictive nature of self-efficacy for academic performance was investigated twice at each exam point, once for the written exam component and once for the laboratory practical component.

Table 2.2a Correlations and Shared Variance between Written Exam and Laboratory Practical Scores for Anatomy Exam 1

Examination Component	n	Mean	Standard Deviation	Correlation Coefficients	Shared Variance
Written Exam 1 (WE1)	143	82.38%	± 7.39%	.67*	45.0%
Lab Practical 1 (LP1)	143	80.69%	± 10.21%		

Table 2.2b Correlations and Shared Variance between Written Exam and Laboratory Practical Scores for Anatomy Exam 2

Exam	n	Mean	Standard Deviation	Correlation Coefficients	Shared Variance
Written Exam 2 (WE2)	133	81.19%	± 7.50%	.66*	43.3%
Lab Practical 2 (LP2)	133	80.49%	± 8.75%		

Table 2.2c Correlations and Shared Variance between Written Exam and Laboratory Practical Scores for Anatomy Exam 3

Exam	n	Mean	Standard Deviation	Correlation Coefficients	Shared Variance
Written Exam 3 (WE3)	122	79.00%	± 7.86%	.70*	49.4%
Lab Practical 3 (LP3)	122	76.19%	± 10.00%		

Table 2.2d Correlations and Shared Variance between Written Exam and Laboratory Practical Scores for Anatomy Exam 4

Exam	n	Mean	Standard Deviation	Correlation Coefficients	Shared Variance
Written Exam 4 (WE4)	112	80.55%	± 9.79	.69*	47.2%
Lab Practical 4 (LP4)	112	82.04%	± 8.85		

These tables show the Pearson product-moment correlation coefficient and the shared variance between the written exam component and the laboratory practical component for each of the four anatomy exams administered during the 2004 Human Anatomy and Embryology course at the UNC-SOM. "*" indicated correlation is significant at the .01 level (2-tailed). Additionally, the table shows the mean and the standard deviation for each component of the four exams.

As long as a participant completed at least 75% of the self-efficacy items at an examination time point, the participant was retained for the analyses at that time point, as was a requirement defined for the PAF procedure in this study.

Question 3: Does a medical student's self-efficacy for the anatomy curriculum at the beginning of the semester predict a student's final score for the course, when controlling for academic ability? To investigate whether initial anatomical self-efficacy (i.e. at the pre-survey) predicts the final score for the course, a hierarchical linear regression analysis was conducted. During these analyses, academic ability was controlled for using the sum of the physical sciences and biological sciences MCAT scores, as MCAT scores have been shown to predict medical school grades (Julian, 2005). The equation being investigated is:

$$\text{final course score} = b_0 + b_1\text{MCAT} + b_2\text{InitialSE} + b_3\text{MCAT*InitialSE}$$

As long as a participant completed at least 75% of the self-efficacy items on the pre-survey, the participant was retained for the analysis, as was a requirement defined for the PAF procedure in this study.

Question 4: When controlling for academic ability, can differences in self-efficacy at the beginning of the medical gross anatomy course be explained by the quantity of prior anatomical experiences? To investigate a whether the quantity of anatomical experience prior to medical school predicts the initial anatomical self-efficacy (i.e. at the pre-survey), a hierarchical linear regression analysis was conducted. During this analysis, academic ability was controlled. Academic ability for each student was defined by the sum of the physical sciences and biological sciences MCAT scores. The equation being investigated is:

$$\text{InitialSE} = b_0 + b_1\text{MCAT} + b_2\text{PriorExperience} + b_3\text{MCAT*PriorExperience}$$

The quantity of anatomical experiences prior to medical school of each participant was obtained from the pre-survey as described above. If the participant did not respond to all 27 questions on the topic of prior experiences, as well as report their gender (as the investigation of prior experience will be linked to gender in a later analysis), the participant was dropped from this analysis. Additionally, the participants needed to complete at least 75% of the self-efficacy items on the pre-survey to be retained for the analysis, as was a requirement defined for the PAF procedure in this study.

Question 5: Are there gender differences in the quantity of previous anatomical experiences? One-way analysis of variance (ANOVA) was used to determine if there were gender differences in quantity of anatomical experiences prior to medical school. The quantity of anatomical experiences prior to medical school of each participant was obtained from the pre-survey as described above. If the participant did not respond to all 27 questions on the topic of prior experiences, as well as their gender, the participant was dropped from this analysis. Additionally, the participants needed to complete at least 75% of the self-efficacy items on the pre-survey to be retained for the analysis, as was a requirement defined for the PAF procedure in this study.

Question 6: When controlling for academic ability, are there gender differences in self-efficacy at the beginning of the medical gross anatomy course? In order to investigate whether gender differences in anatomical self-efficacy exist at the beginning of the semester, an analysis of covariance (ANCOVA) controlling for academic ability was conducted. Academic ability for each student was defined by the sum of the physical sciences and biological sciences MCAT scores and prior to performing the ANCOVA, the homogeneity of slopes assumption was first tested using general linear modeling (GLM). If the participant

did not report their gender, as well as answer all 27 possible questions on the topic of prior experiences (as the investigation of prior experience was be linked to gender in an earlier analysis), the participant was dropped from this analysis. Additionally, the participants needed to complete at least 75% of the self-efficacy items on the pre-survey to be retained for the analysis, as was a requirement defined for the PAF procedure in this study.

Question 7: If they do exist, do differences in self-efficacy due to gender and/or previous experiences still exist at the end of the semester, when controlling for academic ability? If the ANCOVA shows that there are differences in anatomical self-efficacy due to gender and/or if the hierarchical linear regression analysis shows that there are differences in anatomical self-efficacy due to previous anatomical experiences, both when controlling for academic ability, these analyses were to be repeated with the end of the semester self-efficacy ratings (i.e. self-efficacy rating at post-survey 4) to investigate if those differences in self-efficacy due to gender and/or previous experiences dissipate over the semester long course. Again, academic ability for each student was defined by the sum of the physical sciences and biological sciences MCAT scores. If the participant did not report their gender, as well as respond to all 27 questions on the topic of prior experiences, the participant was dropped from this analysis. Additionally, the participants needed to complete at least 75% of the self-efficacy items on the pre-survey to be retained for the analysis, as was a requirement defined for the PAF procedure in this study. Finally, prior to performing the ANCOVA to determine if there are still differences in anatomical self-efficacy due to gender at the end of the semester, the homogeneity of slopes assumption will be first tested using GLM.

The regression equation being investigated to determine if there are still differences in anatomical self-efficacy due to previous anatomical experiences at the end of the semester is:

$$\text{Final SE} = b_0 + b_1\text{MCAT} + b_2\text{PriorExperience} + b_3\text{MCAT*PriorExperience}$$

The final self-efficacy is the self-efficacy at post-survey 4, which was administered following the final examination in the course that tested student knowledge of the head and neck region of the body.

CHAPTER 4

RESULTS

Response Rates

The response rates decreased throughout the duration of survey administration (i.e. over the course of the semester), from a 100% response rate for the pre-survey administration to a 71.97% response rate for the post-survey 4 administered after the final exam, which covered the head and neck region of the human body (see Table 3.1).

Table 3.1 Survey Response Rates

Survey	Number of Surveys Completed	Response Rate
Pre-Survey	157	100%
Post-Survey 1	147	93.63%
Post-Survey 2	137	87.26%
Post-Survey 3	125	79.62%
Post-Survey 4	113	71.97%

This table lists the number of surveys completed by the MS1 participants (n = 157) and the related response rate at each survey administration throughout the semester.

Cleaning of Data

As described in the methods chapter, certain participants were removed from the entire study if they met any of the specified criteria. The following numbers of student participants were dropped from the study for each of those specified criteria:

1) Three participants: The participant did not give permission for their MCAT and/or anatomy exam scores to be released from the registrar's office.
2) One participant: The participant did not complete the course (i.e. they withdrew from the course prior to the end of the semester).

Univariate normality of the continuous data, specifically the quantity of prior anatomical experience, MCAT scores, lab practical scores, written exam scores, end of the course score, and self-efficacy ratings at each time point for both the original reported self-efficacy and the factor score representing self-efficacy obtained through principal axis factoring, was investigated by calculating and examining the skewness and kurtosis statistics. The skewness statistics ranged from -0.834 to 0.994, while the kurtosis statistics ranged from -0.804 to 1.078. These statistics were within acceptable ranges, indicating that data were basically normally distributed and had no significant problems with skewness or kurtosis (Brown, 1997).

Demographics

Descriptive statistics were conducted to provide demographic characteristics for the non-random sample in the areas of age, gender, ethnicity, MCAT score, and previous anatomical experiences. The ages of the MS1 participants reporting their date of birth (n = 153) ranged from 22 years of age to 39 years of age, with the mean being 24.9 years of age (sd = 3.09) on August 1, 2004. Of the MS1 participants reporting their gender (n = 152), 80 (52.6% of total) were male and 72 (47.4% of total) were female. The MCAT scores of MS1 participants (n = 153) ranged from 21 to 39, with the mean being 31.27 (sd = 3.72). Of those MS1 participants reporting the quantity of the anatomical experiences they had prior to

medical school (n = 140), the mean number of anatomical experiences was 3.74 (sd = 2.38), with the number of experiences ranging from 0 to 11.

Of the 151 students that reported their ethnicity, 112 (74.2% of total) reported that they were Caucasian, 20 (13.2% of total) reported they were African American, 9 (6.0% of total) reported they were Asian American, and 6 (4.0% of total) reported they were Indian (Asian Subcontinent). The remainder of the students declared races that included 3 or fewer students, including other. (Note: Students were informed that they were permitted to indicate more than one race category.)

Principal Axis Factoring

The extraction method, principal axis factoring (PAF), yielded two factors for the pre-survey, four factors for post-survey 1, and three factors for post-survey 2, post-survey 3, and post-survey 4 (see Tables 3.2a, 3.3a, 3.4a, 3.5a, and 3.6a). However, the first factor for all five analyses had a much larger eigenvalue than any of the following factors and explained anywhere from 38.36% to 58.69% of the item variance (extraction sum of square loadings variance being reported). The factor loadings indicated that a few items cross loaded at a number of the time points, but not across all the time points, and their loadings were always stronger and positive on the first factor (see Tables 3.2b, 3.3b, 3.4b, 3.5b, and 3.6b). Therefore, all 16 items were retained in one factor, the first factor, now identified as the anatomical self-efficacy rating of the medical students, and the factor scores for factor 1 for the pre-survey, post-survey 1, post-survey 2, post-survey 3, and post-survey 4 were retained as the student anatomical rating of self-efficacy at each respective time point, which corresponded with a survey administration.

Table 3.2a Principal Axis Factoring of Self-Efficacy Items on Pre-Survey: Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.730	60.811	60.811	9.390	58.688	58.688
2	1.347	8.417	69.229	1.026	6.414	65.102

Table 3.2b Principal Axis Factoring of Self-Efficacy Items on Pre-Survey: Factor Matrix

Items	Factor	
	1	2
Self-Efficacy 1	.765	-.225
Self-Efficacy 2	.813	-.159
Self-Efficacy 3	.814	-.064
Self-Efficacy 4	.804	-.217
Self-Efficacy 5	.685	-.033
Self-Efficacy 6	.730	.360
Self-Efficacy 7	.703	.504
Self-Efficacy 8	.752	.175
Self-Efficacy 9	.780	.187
Self-Efficacy 10	.646	.250
Self-Efficacy 11	.827	.012
Self-Efficacy 12	.864	-.250
Self-Efficacy 13	.756	-.345
Self-Efficacy 14	.729	-.107
Self-Efficacy 15	.834	-.258
Self-Efficacy 16	.718	.355

These two tables represent the results of principal axis factoring of the self-efficacy items on the pre-survey, the survey administered prior to the beginning of the gross anatomy course. Table 3.2a indicates that two factors with Eigenvalues over 1 were extracted, whereas Table 3.2b illustrates the item loadings on these two factors.

Table 3.3a Principal Axis Factoring of Self-Efficacy Items on Post-Survey 1: Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.564	41.027	41.027	6.137	38.355	38.355
2	1.458	9.114	50.141	1.014	6.341	44.696
3	1.345	8.407	58.548	0.925	5.781	50.477
4	1.008	6.302	64.850	0.586	3.663	54.140

Table 3.3b Principal Axis Factoring of Self-Efficacy Items on Post-Survey 1: Factor Matrix

Items	Factor			
	1	2	3	4
Self-Efficacy 1	.510	.352	.093	.058
Self-Efficacy 2	.642	.060	.021	.181
Self-Efficacy 3	.514	.425	-.161	-.073
Self-Efficacy 4	.628	.556	-.224	-.233
Self-Efficacy 5	.472	.175	.115	.243
Self-Efficacy 6	.705	.022	-.212	.176
Self-Efficacy 7	.729	-.096	-.326	.310
Self-Efficacy 8	.578	-.391	-.278	.022
Self-Efficacy 9	.665	-.243	-.210	-.313
Self-Efficacy 10	.619	-.096	.217	-.045
Self-Efficacy 11	.673	-.052	.171	-.093
Self-Efficacy 12	.762	-.098	.116	-.356
Self-Efficacy 13	.591	.002	.469	-.064
Self-Efficacy 14	.368	.128	.218	.234
Self-Efficacy 15	.621	-.216	.394	.084
Self-Efficacy 16	.701	-.245	-.203	.044

These two tables represent the results of principal axis factoring of the self-efficacy items on post-survey 1, the survey administered following the exam on the back and upper limb regions of the body. Table 3.3a indicates that four factors with Eigenvalues over 1 were extracted, whereas Table 3.3b illustrates the item loadings on these four factors.

Table 3.4a Principal Axis Factoring of Self-Efficacy Items on Post-Survey 2: Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.118	50.738	50.738	7.728	48.299	48.299
2	1.425	8.906	59.643	1.024	6.403	54.702
3	1.001	6.257	65.900	0.592	3.702	58.404

Table 3.4b Principal Axis Factoring of Self-Efficacy Items on Post-Survey 2: Factor Matrix

Items	Factor		
	1	2	3
Self-Efficacy 1	.654	.405	-.054
Self-Efficacy 2	.664	.157	.213
Self-Efficacy 3	.555	.461	-.164
Self-Efficacy 4	.686	.383	-.066
Self-Efficacy 5	.484	.277	.193
Self-Efficacy 6	.683	.036	-.014
Self-Efficacy 7	.802	-.046	-.117
Self-Efficacy 8	.693	-.344	-.345
Self-Efficacy 9	.740	-.215	-.289
Self-Efficacy 10	.657	-.295	.232
Self-Efficacy 11	.786	-.010	.164
Self-Efficacy 12	.822	-.012	-.063
Self-Efficacy 13	.571	-.051	.178
Self-Efficacy 14	.630	.024	.136
Self-Efficacy 15	.763	-.344	.300
Self-Efficacy 16	.824	-.150	-.185

These two tables represent the results of principal axis factoring of the self-efficacy items on post-survey 2, the survey administered following the exam on the thoracic and abdominal regions of the body. Table 3.4a indicates that three factors with Eigenvalues over 1 were extracted, whereas Table 3.4b illustrates the item loadings on these three factors.

Table 3.5a Principal Axis Factoring of Self-Efficacy Items on Post-Survey 3: Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.553	53.454	53.454	8.198	51.240	51.240
2	1.366	8.539	61.994	.973	6.080	57.320
3	1.192	7.451	69.445	.807	5.044	62.364

Table 3.5b Principal Axis Factoring of Self-Efficacy Items on Post-Survey 3: Factor Matrix

Items	Factor		
	1	2	3
Self-Efficacy 1	.702	.194	.059
Self-Efficacy 2	.742	.247	-.154
Self-Efficacy 3	.512	.269	.454
Self-Efficacy 4	.766	.069	.225
Self-Efficacy 5	.506	.316	.251
Self-Efficacy 6	.794	-.150	.249
Self-Efficacy 7	.795	-.275	.315
Self-Efficacy 8	.677	-.410	.051
Self-Efficacy 9	.686	-.398	-.193
Self-Efficacy 10	.655	-.007	-.309
Self-Efficacy 11	.767	.205	-.188
Self-Efficacy 12	.818	-.023	-.110
Self-Efficacy 13	.699	.245	-.153
Self-Efficacy 14	.618	.233	-.104
Self-Efficacy 15	.780	.062	-.286
Self-Efficacy 16	.833	-.334	.027

These two tables represent the results of principal axis factoring of the self-efficacy items on post-survey 3, the survey administered following the exam on the pelvic and lower limb regions of the body. Table 3.5a indicates that three factors with Eigenvalues over 1 were extracted, whereas Table 3.5b illustrates the item loadings on these three factors.

Table 3.6a Principal Axis Factoring of Self-Efficacy Items on Post-Survey 4: Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.311	51.941	51.941	7.930	49.559	49.559
2	1.177	7.354	59.295	.798	4.986	54.545
3	1.090	6.810	66.106	.690	4.313	58.858

Table 3.6b Principal Axis Factoring of Self-Efficacy Items on Post-Survey 4: Factor Matrix

Items	Factor		
	1	2	3
Self-Efficacy 1	.689	.323	-.050
Self-Efficacy 2	.592	-.033	.111
Self-Efficacy 3	.614	.425	-.291
Self-Efficacy 4	.732	.384	-.121
Self-Efficacy 5	.457	.165	.157
Self-Efficacy 6	.738	-.100	-.180
Self-Efficacy 7	.777	-.119	-.173
Self-Efficacy 8	.679	-.381	-.266
Self-Efficacy 9	.784	-.258	-.206
Self-Efficacy 10	.706	-.109	.338
Self-Efficacy 11	.746	-.055	.264
Self-Efficacy 12	.829	.027	.038
Self-Efficacy 13	.697	.102	.297
Self-Efficacy 14	.570	.147	.028
Self-Efficacy 15	.688	-.132	.289
Self-Efficacy 16	.858	-.188	-.134

These two tables represent the results of principal axis factoring of the self-efficacy items on post-survey 4 the survey administered following the exam on the head and neck region of the body. Table 3.6a indicates that three factors with Eigenvalues over 1 were extracted, whereas Table 3.6b illustrates the item loadings on these three factors.

Coefficient Alpha

The coefficient alpha for the anatomical self-efficacy instrument (composed of all 16 items) ranged from .90 to .96 depending on the survey administration, indicating the scale had a high degree of internal reliability (see Table 3.7).

Table 3.7 Coefficient Alpha for the Self-Efficacy Instrument

Survey	N	Coefficient Alpha
Pre-Survey	145	.96
Post-Survey 1	138	.90
Post-Survey 2	125	.93
Post-Survey 3	117	.94
Post-Survey 4	109	.94

This table shows the coefficient alpha for the self-efficacy instrument embedded in all five surveys. The coefficient alpha for the anatomical self-efficacy instrument (constructed of all 16 self-efficacy items) ranged from .90 to .96 depending on the survey administration, indicating the scale had a high degree of internal reliability.

Question 1: Regardless of prior experiences, gender, and academic ability, how does medical student self-efficacy for the anatomy curriculum change during the semester?

A one-way repeated-measures analysis of variance (ANOVA) was conducted with dependent variable being defined as the self-efficacy rating at each time point. As this was a repeated-measures analysis, the original self-efficacy data was used instead of the PAF factor scores. Only participants that completed at least 75% on all five surveys were retained for this analysis, as was a requirement defined for this study, dropping the n to 89.

The means and standard deviations for the self-efficacy scores are presented in Table 3.8. The results for main effect indicated a statistically significant time effect [Wilks's Λ = .73, $F(4, 85) = 8.059$, $p < .001$]. It should be noted that the Mauchly's Test of Sphericity was

significant and, therefore, the ANOVA results are being interpreted using multivariate tests, as sphericity is not an assumption for multivariate tests.

Table 3.8 Original Self-Efficacy Means for Each Survey Administration

Survey	n	Mean of Self-Efficacy Score	Standard Deviation	Minimum	Maximum
Pre-Survey	89	3.25	0.73	1.13	4.81
Post-Survey 1	89	3.50	0.48	2.25	4.56
Post-Survey 2	89	3.45	0.57	1.63	4.75
Post-Survey 3	89	3.41	0.59	2.13	4.81
Post-Survey 4	89	3.57	0.59	2.19	4.88

This table shows the self-efficacy mean, the standard deviation, minimum and maximum for each survey administration obtained by averaging each student's responses to the 16 self-efficacy items. This mean self-efficacy rating at each time point was used in a one-way repeated-measures analysis of variance (ANOVA) to investigate whether there was a change in the self-efficacy over the semester. Also, shown are the minimum and maximum self-efficacy averages for each survey administration. The repeated-measure ANOVA indicated that there was a significant difference in self-efficacy across the semester of Human Anatomy and Embryology [Wilks's $\Lambda = .73$, $F(4, 85) = 8.059$, $p < .001$].

As the main effects ANOVA found a significant main effect [i.e. self-efficacy does change over time (i.e. the semester)], pairwise comparisons were conducted to determine which means were different from one another. Using paired-samples *t*-tests, three significant ($p \leq .005$) comparisons were found (see Figure 3.1 and Table 3.9). [The significance level for the pairwise comparisons was $p \leq .005$, as determined using the Bonferroni correction (i.e. .05/10 contrasts).] First, the self-efficacy mean from the pre-survey administered at the beginning of the course [mean = 3.25 (sd = 0.73)] was lower than the self-efficacy mean for post-survey 1 administered after the course exam on the back and upper limb regions of the body [mean = 3.50 (sd = 0.48)] [$t(88) = -3.500$, $p = .001$; $d = .36$]. Secondly, the self-efficacy mean for the pre-survey administered prior to the beginning of the course [mean =

3.25 (sd = 0.73)] was lower than the self-efficacy mean for post-survey 4 administered after the exam on the head and neck region [mean = 3.57 (sd = 0.59)] [$t(88) = -3.629$, $p < .001$; $d = .38$]. Lastly, the self-efficacy mean for post-survey 3 [mean = 3.41 (sd = 0.59)] was lower than the self-efficacy mean for post-survey 4 administered after the exam on the head and neck region of the body [i.e. 3.57 (sd = 0.59)] [$t(88) = -4.326$, $p < .001$; $d = .44$].

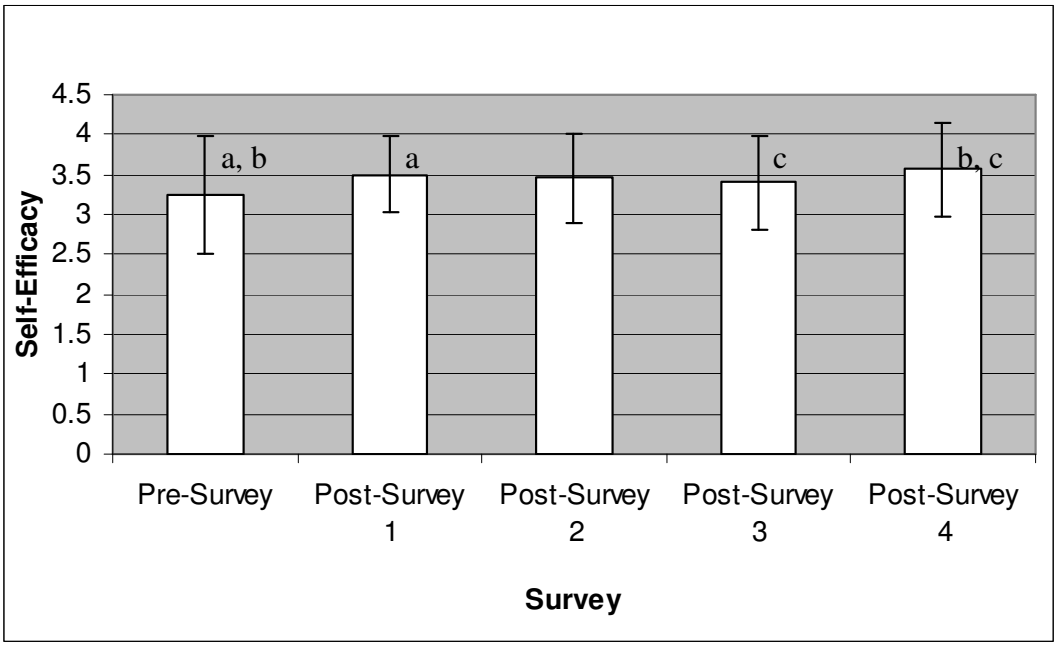

Figure 3.1 Pairwise Comparisons of Original Self-Efficacy Means Across the Semester. This figure shows the original self-efficacy means for each survey administration with bars representing one standard deviation, as well as the results of pairwise comparisons to determine which original self-efficacy means were different from one another. Pairwise comparisons were conducted as the ANOVA found a statistically significant main effect [i.e. self-efficacy changed over time (i.e. the semester)]. Using paired-samples *t*-tests, three statistically significant ($p \leq .005$) comparisons were found, which are indicated by "a", "b", and "c". The significance level for the pairwise comparisons was $p \leq .005$, as determined using the Bonferroni correction (i.e. .05/10 contrasts).

Table 3.9 Pairwise Comparisons of Original Self-Efficacy Means Across the Semester

Contrast	Differences Between Means	Standard Deviation	*t*	df	Significance	Cohen's *d*
Pre-Survey - Post-Survey 1	-0.25	0.69	-3.500	88	.001*	.41
Pre-Survey - Post-Survey 2	-0.21	0.78	-2.533	88	.013	.32
Pre-Survey - Post-Survey 3	-0.16	0.85	-1.775	88	.079	.24
Pre-Survey - Post-Survey 4	-0.32	0.84	-3.629	88	< .001*	.49
Post-Survey 1 - Post-Survey 2	0.05	0.38	1.154	88	.252	.09
Post-Survey 1 - Post-Survey 3	0.09	0.49	1.835	88	.070	.18
Post-Survey 1 - Post-Survey 4	-0.07	0.49	-1.321	88	.190	.13
Post-Survey 2 - Post-Survey 3	0.05	0.44	1.025	88	.308	.08
Post-Survey 2 - Post-Survey 4	-0.12	0.45	-2.399	88	.019	.20
Post-Survey 3 - Post-Survey 4	-0.16	0.36	-4.326	88	< .001*	.28

This table shows the results pairwise comparisons conducted to determine which original self-efficacy means were different from one another as the ANOVA found a statistically significant main effect [i.e. self-efficacy does change over time (i.e. the semester)]. Additionally, an estimate of effect size was measured with Cohen's *d*. Using paired-samples *t*-tests, three statistically significant ($p \leq .005$) comparisons were found. The significance level for the pairwise comparisons was $p \leq .005$, as determined using the Bonferroni correction (i.e. .05/10 contrasts). P-values that are statistically significant are marked with an "*".

These results indicated that self-efficacy changed over the course of the semester. Specifically, on average self-efficacy increased between the pre-survey administered at the beginning of the course and post-survey 1 administered after the exam on the back and upper limb regions of the body, between the pre-survey administered at the beginning of the course and post-survey 4 administered after the exam on the head and neck region of the body, and between post-survey 3 administered after the exam on the pelvic and lower limb regions of the body and post-survey 4 administered after the course exam on the head and neck region of the body. These results did support the hypothesis that there would be a change in self-efficacy during the semester. More specifically, these results supported the hypothesis that medical student self-efficacy for the anatomy curriculum would increase statistically significantly at the beginning of the semester. However, it was hypothesized that self-efficacy would remain unchanged later in the semester, which was unsupported by these results.

Question 2: Do anatomical self-efficacy ratings predict measures of academic performance (i.e. laboratory practical scores and/or written exam scores) in the medical gross anatomy course, when controlling for academic ability?

To investigate whether anatomical self-efficacy ratings predict academic performance at each of the four exam administrations, hierarchical linear regression analyses were conducted (see Table 3.10). For these analyses, academic ability, defined as the sum of the MCAT Physical Sciences section and MCAT Biological Sciences section scores, was controlled. The student anatomical self-efficacy ratings at each examination point used in these analyses were the first factor scores retained from PAF.

Table 3.10 Results of Hierarchical Linear Regressions Investigating the Predictive Nature of Self-Efficacy for Academic Performance Controlling for Academic Ability

Portion of Exam	Exam Content	F Change	df1	df2	*p*	Standardized β Weights for Self-Efficacy	R Square Change
LP1	Back and Upper Limb	11.478	1	140	.001*	.269	.072
WE1	Back and Upper Limb	3.172	1	140	.077	.143	.020
LP2	Thorax and Abdomen	10.130	1	130	.002*	.265	.070
WE2	Thorax and Abdomen	6.064	1	130	.015*	.207	.043
LP3	Pelvis and Lower Limb	20.794	1	119	<.001*	.378	.143
WE3	Pelvis and Lower Limb	6.798	1	119	.010*	.223	.050
LP4	Head and Neck	7.286	1	109	.008*	.241	.056
WE4	Head and Neck	1.189	1	109	.278	.097	.009

This table shows the results of the hierarchical linear regression analyses to investigate the predictive nature of anatomical self-efficacy for academic performance at each of the four exam points, controlling for academic ability. Academic ability was defined as the sum of the Physical Sciences and Biological Sciences MCAT section scores. Self-efficacy, when controlling for academic ability, predicted all four laboratory practicals (i.e. LP1, LP2, LP3, and LP4) and two of the four written practicals (i.e. WE2 and WE3). [Key: LP = Lab Practical; WE = Written Exam; * = statically significant ($p \leq 0.05$)]

Examination 1 (E1), consisting of a laboratory practical (LP1) component and written exam (WE1) component, was the first examination in the Human Anatomy and Embryology course and covered course material on the back and upper limb regions of the human body. At E1, 143 participants completed at a minimum 75% of the self-efficacy items on post-survey 1, as was a requirement defined for the PAF procedure in this study, and were therefore retained for the analyses. Of those participants, the mean self-efficacy rating at the time of the post-survey 1 completion was 0 (sd = 0.97) and the mean MCAT science score

was 21.15 (sd = 2.98). The score on LP1 [mean = 80.69 (sd = 10.21)] was predicted by the MCAT science score [R^2 change = .052, $F(1, 141) = 7.677$, $p = .006$]. The score on LP1 was then predicted by the self-efficacy rating at that time point [R^2 change = .072, $F(1, 140) = 11.478$, $p = .001$, $\beta = .269$], when MCAT science score was controlled. The score on WE1 [mean = 82.38 (sd = 7.389)] was predicted by the MCAT science score [R^2 change = .086, $F(1, 141) = 13.279$, $p < .001$]. The score on WE1 was not predicted by the self-efficacy rating at that time point [R^2 change = .020, $F(1, 140) = 3.172$, $p = .077$, $\beta = .143$], when MCAT science score was controlled. The interaction term between the post-survey 1 self-efficacy rating and MCAT science score was not significant in the LP1 analysis [R^2 change = .000, $F(1, 139) = 0.029$, $p = .865$] or the WE1 analysis [R^2 change = .001, $F(1, 139) = 0.220$, $p = .640$], indicating no interaction effect.

Examination 2 (E2), consisting of a laboratory practical (LP2) component and written exam (WE2) component, was the second examination in the Human Anatomy and Embryology course and covered course material on the thoracic and abdominal regions of the human body. At E2, 133 participants completed at a minimum 75% of the self-efficacy items on post-survey 2, as was a requirement defined for the PAF procedure in this study, and were therefore retained for the analyses. Of those participants, the mean self-efficacy rating at the time of the post-survey 2 completion was 0 (sd = 0.98) and the mean MCAT science score was 21.20 (sd = 2.90). The score on LP2 [mean = 80.49 (sd = 8.75)] was predicted by the MCAT science score [R^2 change = .029, $F(1, 131) = 3.974$, $p = .048$]. The score on LP2 was then predicted by the self-efficacy rating at that time point [R^2 change = .070, $F(1, 130) = 10.130$, $p = .002$, $\beta = .265$], when MCAT science score was controlled. The score on WE2 [mean = 81.19 (sd = 7.50)] was predicted by the MCAT science score [R^2

change = .044, $F(1, 131) = 6.018$, $p = .015$]. The score on WE2 was then predicted by the self-efficacy rating at that time point [R^2 change = .043, $F(1, 130) = 6.064$, $p = .015$, $\beta = .207$], when MCAT science score was controlled. The interaction term between the post-survey 2 self-efficacy rating and MCAT science score was not significant in the LP2 analysis [R^2 change = .000, $F(1, 129) = 0.021$, $p = .884$] or the WE2 analysis [R^2 change = .000, $F(1, 129) = 0.021$, $p = .886$], indicating no interaction effect.

Examination 3 (E3), consisting of a laboratory practical (LP3) component and written exam (WE3) component, was the third examination in the Human Anatomy and Embryology course and covered course material on the pelvic and lower limb regions of the human body. At E3, 122 participants completed at a minimum 75% of the self-efficacy items on post-survey 3, as was a requirement defined for the PAF procedure in this study, and were therefore retained for the analyses. Of those participants, the mean self-efficacy rating at the time of the post-survey 3 completion was 0 (sd = 0.98) and the mean MCAT science score was 21.22 (sd = 3.00). The score on LP3 [mean = 76.19 (sd = 10.00)] was predicted by the MCAT science score [R^2 change = .041, $F(1, 120) = 5.155$, $p = .025$]. The score on LP3 was then predicted by the self-efficacy rating at that time point [R^2 change = .143, $F(1, 119) = 20.794$, $p < .001$, $\beta = .378$], when MCAT science score was controlled. The score WE3 [mean = 79.00 (sd = 7.89)] was predicted by the MCAT science score [R^2 change = 0.077, $F(1, 120) = 10.017$, $p = 0.002$]. The score on WE3 was then predicted by the self-efficacy rating at that time point [R^2 change = .050, $F(1, 119) = 6.798$, $p = .010$, $\beta = .223$], when MCAT science score was controlled. The interaction term between the post-survey 3 self-efficacy rating and MCAT science score was not significant in the LP3 analysis [R^2 change =

.000, $F(1, 118) = 0.000$, $p = 1.000$] or the WE3 analysis [R^2 change = .012, $F(1, 118) = 1.621$, $p = .205$], indicating no interaction effect.

Examination 4 (E4), consisting of a laboratory practical (LP4) component and written exam (WE4) component, was the fourth and final examination in the Human Anatomy and Embryology course and covered course material on the head and neck region of the human body. At E4, 112 participants completed at a minimum 75% of the self-efficacy items on post-survey 4, as was a requirement defined for the PAF procedure in this study, and were therefore retained for the analyses. Of those participants, the mean self-efficacy rating at the time of the post-survey 4 completion was 0 (sd = 0.98) and the mean MCAT science score was 21.15 (sd = 2.97). The score on LP4 [mean = 82.04 (sd = 8.85)] was predicted by the MCAT science score [R^2 change = .100, $F(1, 110) = 12.178$, $p = .001$]. The score on LP4 was then predicted by the self-efficacy rating at that time point [R^2 change = .056, $F(1, 109) = 7.286$, $p = .008$, $\beta = .241$], when MCAT science score was controlled. The score on WE4 [mean = 80.55 (sd = 9.79)] and was predicted by the MCAT science score [R^2 change = .155, $F(1, 110) = 20.205$, $p < .000$]. The score on WE4 was not predicted by the self-efficacy rating at that time point [R^2 change = .009, $F(1, 109) = 1.189$, $p = .278$, $\beta = .097$], when MCAT science score was controlled. The interaction term between the post-survey 4 self-efficacy rating and MCAT science score was not significant in the LP4 analysis [R^2 change = .010, $F(1, 108) = 1.275$, $p = .261$] or the WE4 analysis [R^2 change = .000, $F(1, 108) = 0.002$, $p = .962$], indicating no interaction effect.

The results of the hierarchical linear regressions to investigate the predictive nature of anatomical self-efficacy for academic performance, while controlling for academic ability, indicated that all four laboratory practicals (i.e. LP1, LP2, LP3, and LP4) scores were

predicted by the corresponding self-efficacy ratings, while two (i.e. WE2 and WE3) of the four written exams scores were predicted by the corresponding self-efficacy ratings. The two written exams scores that were predicted by anatomical self-efficacy were the second exam covering the thoracic and abdominal regions of the body and the third exam covering the pelvic and lower limb regions of the body. The two written exam scores not predicted by the anatomical self-efficacy were the first exam covering the back and upper limb regions of the body and the fourth exam covering the head and neck regions of the body. More often then not, these results supported the hypothesis that the anatomical self-efficacy of the medical students would predict the scores on both the laboratory practical and written exam components.

Question 3: Does a medical student's self-efficacy for the anatomy curriculum at the beginning of the semester predict a student's final score for the course, when controlling for academic ability?

To investigate whether the initial anatomical self-efficacy ratings of students predict the final score for the Human Anatomy and Embryology course, a hierarchical linear regression analysis was conducted. During the analysis, academic ability was controlled. Academic ability for each student was defined by the sum of the Physical Sciences and Biological Sciences MCAT section scores. The initial student anatomical self-efficacy ratings used in the analysis were the first factor scores retained from PAF conducted using the self-efficacy responses on the pre-survey.

At the pre-survey, 153 participants completed a minimum 75% of the self-efficacy items, as was a requirement defined for the PAF procedure in this study and were therefore retained for the analyses. Of those participants, the mean self-efficacy rating at the time of

pre-survey completion was 0 (sd = 0.98) and the mean MCAT science score was 21.08 (sd = 2.96). The final score for the Human Anatomy and Embryology course [mean = 79.61 (sd = 6.83)] was predicted by the MCAT science score [R^2 change = .141, $F(1, 151) = 24.831$, $p < .001$]. The final score for the course was not predicted by the self-efficacy rating at the beginning of the semester [R^2 change = .000, $F(1, 150) = 0.066$, $p = .798$, $\beta = .019$], when MCAT science score was controlled. The interaction term between the self-efficacy rating at the pre-survey completion and MCAT science score was not significant [R^2 change = .001, $F(1, 149) = 0.202$, $p = .653$], indicating no interaction effect.

The results of the hierarchical linear regression to investigate whether initial anatomical self-efficacy of medical students predicted their final score for the Human Anatomy and Embryology course, while controlling for academic ability, indicated that the final score in the course was not predicted by the medical student self-efficacy at the beginning of the course. These results did not support the hypothesis that those students with higher self-efficacy at the beginning of the course would have a higher final score for the course than their classmates with lower initial self-efficacy for the anatomy curriculum.

Question 4: When controlling for academic ability, can differences in self-efficacy at the beginning of the medical gross anatomy course be explained by the quantity of prior anatomical experiences?

To investigate whether the quantity of anatomical experiences prior to medical school predicted the initial anatomical self-efficacy of students as they entered the medical gross anatomy course, a hierarchical linear regression analysis was conducted. During this analysis, academic ability was controlled. Academic ability for each student was defined by the sum of the Physical Sciences and Biological Sciences MCAT section scores. The initial

student anatomical self-efficacy ratings used in the analysis were the first factor scores retained from PAF conducted using the self-efficacy responses on the pre-survey. For this analysis, an additional 14 participants were dropped from the analyses as they either did not report or did not completely report their prior anatomical experiences prior to medical school in the pre-survey (13 participants) or did not report their gender in the pre-survey (1 participant).

At the pre-survey, 139 participants completed a minimum 75% of the self-efficacy items (as was a requirement defined for the PAF procedure in this study), reported their gender, and completely reported the quantity of anatomical experiences prior to medical school. Of those 139 participants, the mean self-efficacy rating at the time of pre-survey completion was 0 (sd = 0.98), the mean MCAT science score was 21.24 (sd = 2.91), and the mean quantity of previous anatomical experiences was 3.75 (sd = 2.39) (range 0-11). The initial anatomical self-efficacy of the MS1 students was not predicted by the MCAT science score [R^2 change = .001, $F(1, 137) = 0.168$, $p = .683$]. However, the initial anatomical self-efficacy (i.e. self-efficacy rating at pre-survey administration) was predicted by the quantity of previous anatomical experiences [R^2 change = .069, $F(1, 136) = 10.060$, $p = .002$, $\beta = .270$], when MCAT science score was controlled. The interaction term between the quantity of previous anatomical experiences and MCAT science score was not significant [R^2 change = .005, $F(1, 135) = 0.704$, $p = .403$], indicating no interaction effect.

The results of the hierarchical linear regression analysis to investigate a possible relation between initial anatomical self-efficacy and the quantity of anatomical experiences prior to medical school, while controlling for academic ability, indicated that the quantity of previous anatomical experiences predicted the initial anatomical self-efficacy of the MS1

participants. The results indicated that those students with more anatomical experience prior to medical school had higher initial anatomical self-efficacy, while those students with less anatomical experience prior to medical school had lower initial anatomical self-efficacy. These results supported the hypothesis that those medical students with higher levels of previous anatomical experiences prior to medical school would have higher self-efficacy for the anatomy curriculum, even with academic ability taken into account.

Question 5: Are there gender differences in the quantity of previous anatomical experiences?

ANOVA was used to determine if there were gender differences in quantity of anatomical experiences of students prior to medical school. For this analysis, an additional 14 participants were dropped from the analyses as they either did not report or did not completely report their prior anatomical experiences prior to medical school in the pre-survey (13 participants) or did not report their gender in the pre-survey (1 participant).

At the pre-survey, 139 participants (female = 66; male = 73) completed a minimum 75% of the self-efficacy items (as was a requirement defined for the PAF procedure in this study), reported their gender, and completely reported the quantity of anatomical experiences prior to medical school. The ANOVA indicated that no statistically significant difference [$F(1, 137) = 1.575$, $p = .212$)] existed between the mean amount of anatomical experiences prior to medical school between females [4.02 (sd = 2.46)] and males [3.51 (sd = 2.32)] (see Table 3.11 and Figure 3.2).

The results of the ANOVA used to determine if there were gender differences in quantity of anatomical experiences prior to medical school indicated that MS1 males and females had the same quantity of anatomical experiences prior to medical school. These

Table 3.11 Descriptive Statistics of Anatomical Experiences of Students Prior to Medical School by Gender

Gender	N	Mean Prior Anatomical Experiences	Standard Deviation	Minimum	Maximum
Female	66	4.02	2.46	0	11
Male	73	3.51	2.32	0	10

This table shows the mean, standard deviation, minimum, and maximum of the quantity of anatomical experiences of students prior to medical school by gender. ANOVA indicated that no statistically significant difference [$F(1, 137) = 1.575$, $p = .212$)] existed between the mean amount of anatomical experiences prior to medical school between female and male students.

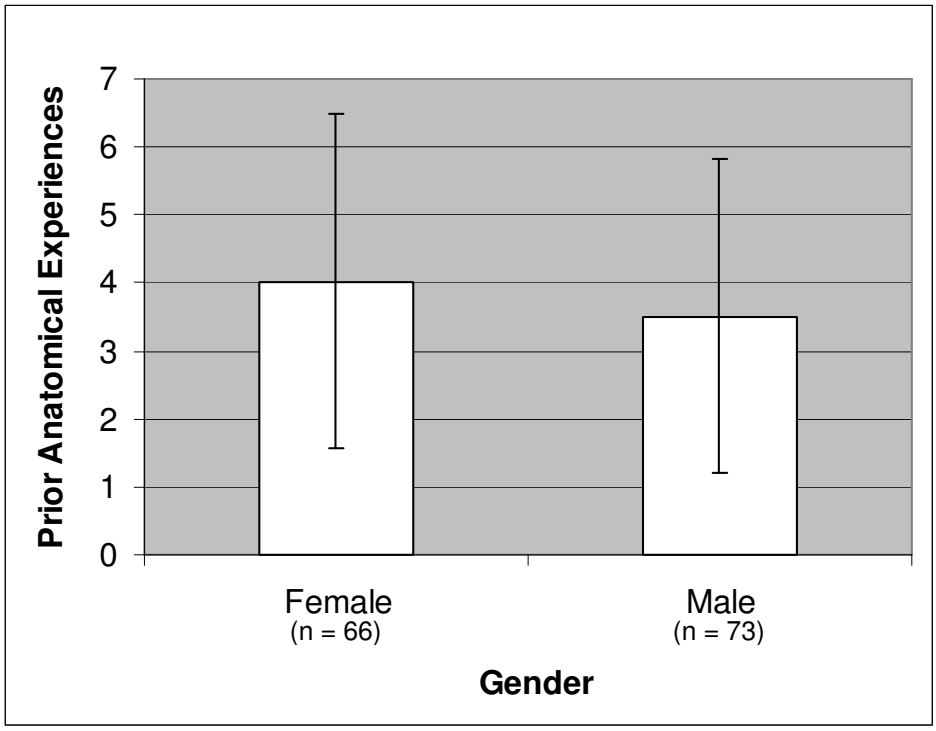

Figure 3.2 Quantity of Anatomical Experiences of Students Prior to Medical School by Gender. This figure shows quantity of anatomical experiences of students prior to medical by gender, with bars representing one standard deviation. ANOVA indicated that no statistically significant difference [$F(1, 137) = 1.575$, $p = .212$)] existed between the mean amount of anatomical experiences prior to medical school between female and male students.

results did not support the hypothesis that the female medical students would have fewer previous anatomical experiences prior to medical school than their male counterparts.

Question 6: When controlling for academic ability, are there gender differences in self-efficacy at the beginning of the medical gross anatomy course?

In order to investigate whether gender differences in anatomical self-efficacy exist at the beginning of the semester, an analysis of covariance (ANCOVA) controlling for academic ability was conducted. Academic ability for each student was defined by the sum of the Physical Sciences and Biological Sciences MCAT section scores. The student anatomical self-efficacy ratings used in the analysis were the first factor scores retained from PAF conducted using the self-efficacy responses on the pre-survey. For this analysis, an additional 14 participants were dropped from the analyses as they either did not report or did not completely report their prior anatomical experiences prior to medical school in the pre-survey (13 participants) or did not report their gender in the pre-survey (1 participant).

Prior to performing the ANCOVA, homogeneity of slopes was investigated with general linear modeling, where the results of the interaction effect test (MCAT*Gender) via regression showed no significance [$F(1,135) = 2.500$, $p = .116$]. Therefore, ANCOVA was conducted assuming homogeneity of slopes.

At the pre-survey, 139 participants (female = 66; male = 73) completed a minimum 75% of the self-efficacy items (as was a requirement defined for the PAF procedure in this study), reported their gender, and completely reported the quantity of anatomical experiences prior to medical school. At the beginning of the course, the estimated mean female anatomical self-efficacy rating was -0.25 (std. error = 0.12) and the estimated mean male anatomical self-efficacy rating was 0.23 (std. error = 0.12), when controlling for academic

ability (see Table 3.12 and Figure 3.3). (Note: The negative value of the female estimated mean for the initial self-efficacy rating does not indicate that the female self-efficacy was negative, only that it was lower than the male self-efficacy rating.) When controlling for academic ability, on average females had statistically significant lower anatomical self-efficacy at the beginning of the course than did males [$F(1, 136) = 7.554$, $p = .007$].

The results of the ANCOVA to investigate whether gender differences in anatomical self-efficacy exist at the beginning of the semester, while controlling for academic ability, indicated that on average females had statistically significant lower anatomical self-efficacy at the beginning of the course than did their male counterparts. These results supported the hypothesis that the gender differences in science self-efficacy would still be prevalent at the medical school level and, therefore, female medical students would exhibit a lower self-efficacy than their male counterparts.

Table 3.12 Estimated Mean of Student Anatomical Self-Efficacy by Gender at the Beginning of the Anatomy Course Controlling for Academic Ability

Gender	n	Estimated Self-Efficacy Mean	Standard Error
Female	66	-0.25*	0.12
Male	73	0.23*	0.12

This table shows the estimated mean and standard error of the anatomical self-efficacy ratings of students by gender at the beginning of the Human Anatomy and Embryology course (i.e. at the pre-survey) controlling for academic ability. (Note: The negative value of the female adjusted mean for the initial self-efficacy rating does not indicate that the female self-efficacy was negative, only that it was lower than the male self-efficacy rating.) The "*" indicates that when controlling for academic ability, females had significantly lower anatomical self-efficacy than males at the beginning of the course [$F(1, 136) = 7.554$, $p = .007$].

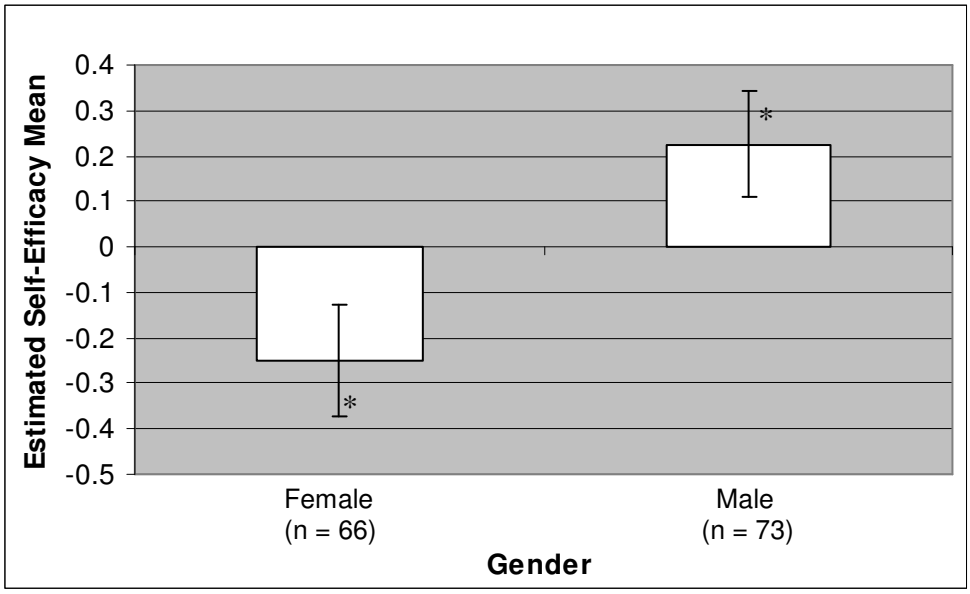

Figure 3.3 Estimated Self-Efficacy Mean at Beginning of Semester by Gender Controlling for Academic Ability. This figure shows the estimated mean of the anatomical self-efficacy ratings of students by gender at the beginning of the Human Anatomy and Embryology course (i.e. at the pre-survey) controlling for academic ability. The bars represent one standard error. (Note: The negative value of the female adjusted mean for the initial self-efficacy rating does not indicate that the female self-efficacy was negative, only that it was lower than the male self-efficacy rating.) The "*" indicates that when controlling for academic ability, females had significantly lower anatomical self-efficacy than males at the beginning of the course [$F(1, 136) = 7.554$, $p = .007$].

The results of the ANCOVA to investigate whether gender differences in anatomical self-efficacy exist at the beginning of the semester, while controlling for academic ability, indicated that on average females had statistically significant lower anatomical self-efficacy at the beginning of the course than did their male counterparts. These results supported the hypothesis that the gender differences in science self-efficacy would still be prevalent at the medical school level and, therefore, female medical students would exhibit a lower self-efficacy than their male counterparts.

Question 7: If they do exist, do differences in self-efficacy due to gender and/or previous experiences still exist at the end of the semester, when controlling for academic ability?

An ANCOVA showed that were differences in anatomical self-efficacy at the beginning of the semester due to gender and a hierarchical regression analysis showed that there were differences in anatomical self-efficacy at the beginning of the semester due to previous anatomical experiences, both when controlling for academic ability. Therefore, these analyses were repeated with the end of the semester self-efficacy ratings (i.e. self-efficacy rating at post-survey 4) to investigate if those differences in self-efficacy due to gender and previous experiences still existed at the end of the semester, when controlling for academic ability. Academic ability for each student was defined by the sum of the Physical Sciences and Biological Sciences MCAT section scores. The student anatomical self-efficacy ratings used in these final analyses were the first factor scores retained from PAF conducted using the self-efficacy responses on post-survey 4. Post-survey was administered following the fourth and final exam of the course, which covered the head and neck region of the human body. Of the participants that submitted post-survey 4, an additional 7 participants were dropped from the analyses as they either did not report or did not completely report their prior anatomical experiences prior to medical school in the pre-survey.

Prior to performing the ANCOVA to investigate if differences in anatomical self-efficacy existed at the end of the semester due to gender, homogeneity of regression was investigated with general linear modeling, where the results of the interaction effect test (MCAT*Gender) via regression showed was not significant [$F(1, 101) = 0.002$, $p = .969$]. Therefore, ANCOVA was conducted assuming homogeneity of slopes.

At post-survey 4, 105 participants (female = 54; male = 51) completed a minimum 75% of the self-efficacy items (as was a requirement defined for the PAF procedure in this study), reported their gender, and completely reported the quantity of anatomical experiences prior to medical school. At the end of the course, the estimated mean female anatomical self-efficacy rating was -0.26 (std. error = 0.13), while the estimated mean male anatomical self-efficacy rating was 0.29 (std. error = 0.13), when controlling for academic ability (see Table 3.12 and Figure 3.4). (Note: The negative value of the female adjusted mean for the initial self-efficacy rating does not indicate that the female self-efficacy was negative, only that it was lower than the male self-efficacy rating.) When controlling for academic ability, on average females still had statistically significant lower anatomical self-efficacy at the end of the Human Anatomy and Embryology course than did males [$F(1, 102) = 8.135$, $p = .005$].

Table 3.13 Estimated Mean of Student Anatomical Self-Efficacy by Gender at the End of the Anatomy Course Controlling for Academic Ability

Gender	n	Adjusted Mean Self-Efficacy Rating	Standard Error
Female	54	-0.26*	0.13
Male	51	0.29*	0.13

This table shows the estimated mean and the standard error of the anatomical self-efficacy ratings of students by gender at the end of the Human Anatomy and Embryology course (i.e. at post-survey 4) controlling for academic ability. (Note: The negative value of the female adjusted mean for the initial self-efficacy rating does not indicate that the female self-efficacy was negative, only that it was lower than the male self-efficacy rating.) The "*" indicates that when controlling for academic ability, females had significantly lower anatomical self-efficacy than males at the end of the course [$F(1, 102) = 8.135$, $p = .005$].

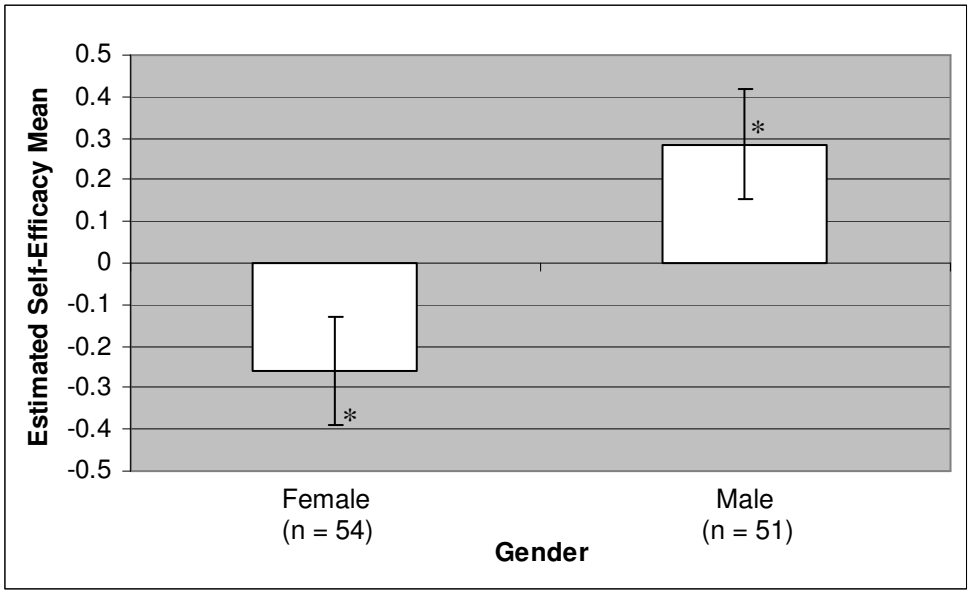

Figure 3.4 Estimated Self-Efficacy Mean at End of Semester by Gender Controlling for Academic Ability. This figure shows the estimated mean of the anatomical self-efficacy ratings of students by gender at the end of the Human Anatomy and Embryology course (i.e. at post-survey 4) controlling for academic ability. The bars represent one standard error. (Note: The negative value of the female adjusted mean for the initial self-efficacy rating does not indicate that the female self-efficacy was negative, only that it was lower than the male self-efficacy rating.) The "*" indicates that when controlling for academic ability, females had significantly lower anatomical self-efficacy than males at the end of the course [$F(1, 102) = 8.135$, $p = .005$].

The results of the ANCOVA to investigate whether gender differences in anatomical self-efficacy still existed at the end of the semester, while controlling for academic ability, indicated that on average females still had statistically significant lower anatomical self-efficacy at the end of the course as compared to their male counterparts. These results supported the hypothesis that the gender differences in anatomical self-efficacy would still be prevalent at the end of the semester, with female medical students exhibiting a lower self-efficacy than their male counterparts.

At post-survey 4, 105 participants completed a minimum 75% of the self-efficacy items (as was a requirement defined for the PAF procedure in this study), reported their gender, and completely reported the quantity of anatomical experiences prior to medical school. Of those 105 participants, the mean self-efficacy rating at the time post-survey 4 was 0 (sd = 0.97), the mean MCAT science score was 21.22 (sd = 2.94), and the quantity of previous anatomical experiences was 3.93 (sd = 2.33) (range 0-11). The anatomical self-efficacy of the MS1 students at post-survey 4 was predicted by MCAT science score [R^2 change = .037, $F(1, 103) = 3.970$, $p = .049$], unlike at the beginning of the course (i.e. at the pre-survey). The anatomical self-efficacy at post-survey 4 was not predicted by the quantity previous anatomical experiences [R^2 change = .000, $F(1, 102) = 0.034$, $p = .855$, $\beta = -.018$], when MCAT science score was controlled. This result was opposite than what was observed at the beginning of the semester where previous anatomical experiences alone predicted initial self-efficacy after MCAT science score was controlled. Additionally, the interaction term between the quantity of previous anatomical experiences and MCAT science score was now significant when predicting final self-efficacy [R^2 change = 0.059, $F(1, 101) = 6.641$, $p = 0.011$], indicating that the previous anatomical experiences and MCAT science scores were no longer independent and had a multiplicative influence on self-efficacy ratings at the end of the course. A graph of this interaction (Figure 3.5) indicates that as students had a higher quantity of prior anatomical experience, the relation between MCAT science score and self-efficacy became stronger.

The results of the hierarchical linear regression analysis showed that, when controlling for academic ability, the quantity of previous anatomical experiences alone no longer predicted the anatomical self-efficacy ratings of the MS1 participants at end of the

Human Anatomy and Embryology course. However, when predicting self-efficacy at the end of the semester, there was an interaction between prior anatomical experience and academic ability (i.e. MCAT science score). The graphing of the interaction of MCAT science score and previous anatomical experience indicated that as students had more prior anatomical experience, the relation between MCAT science score and self-efficacy became stronger.

Overall, these results did not support the hypothesis that as the semester progressed, those students with lower previous anatomical experiences would continue to have lower self-efficacy for the anatomy curriculum than those students with higher previous anatomical experiences.

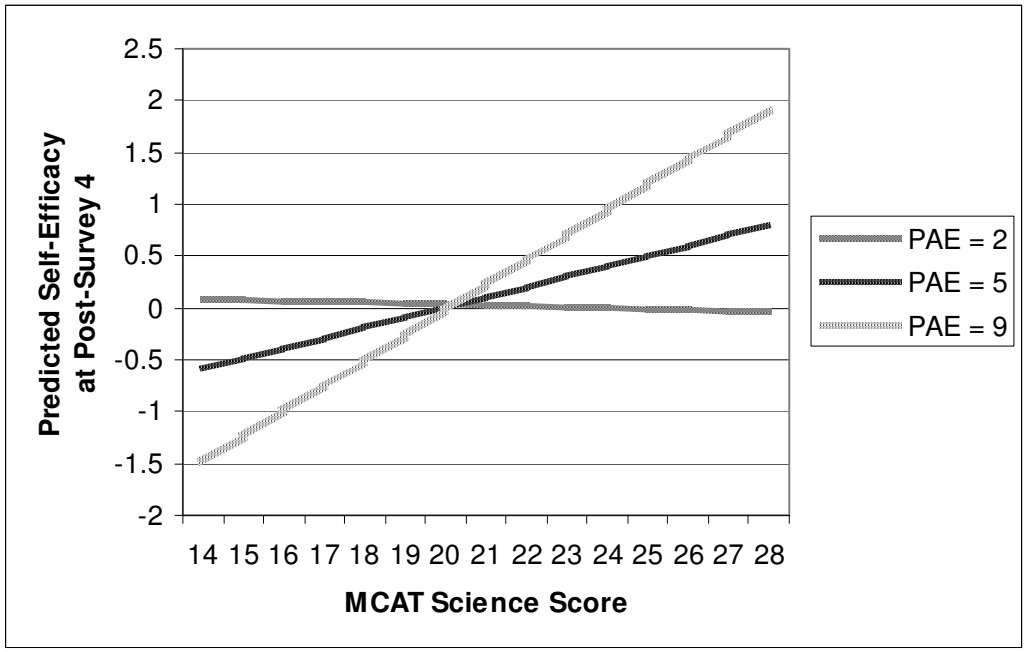

Figure 3.5 Interaction Between MCAT Science Score and Prior Anatomical Experience Observed When Predicting Self-Efficacy at Post-Survey 4. This graph illustrates the interaction effect found between MCAT science score and prior anatomical experience (PAE) when predicting self-efficacy at post-survey 4, using the formula obtained from the hierarchical linear regression [Final SE = 1.683 + (-0.081)MCAT + (-0.73)PriorExperience + (0.036)MCAT*PriorExperience]. The graph illustrates that as students had more prior experience, the relation between MCAT and self-efficacy became stronger.

CHAPTER 5

DISCUSSION

The overall purpose of this research was to investigate several research questions and hypotheses about medical student self-efficacy for the anatomy curriculum, a new area of research. In this chapter, for each of the research questions, a summary of study findings will be provided, how those findings supported or did not support the hypothesizes made, how the results relate to prior research, how the results contribute to the understanding of self-efficacy, any potential problems with the study, and/or practical implications for the medical gross anatomy curriculum due to the research findings. The final portion of the chapter will discuss some potential areas for future research to further the understanding of anatomical self-efficacy and its influence on behavior.

Question 1: Regardless of prior experiences, gender, and academic ability, how does medical student self-efficacy for the anatomy curriculum change during the semester?

A one-way repeated-measures analysis of variance (ANOVA) was conducted with the dependent variable being defined as the self-efficacy rating at each time point. The main effects ANOVA found a statistically significant effect, indicating that self-efficacy did change over the semester, which supported the hypothesis that there would be a change in the anatomical self-efficacy of medical students during the semester.

Using paired-samples *t*-tests, three statistically significant comparisons were found, namely: 1) the self-efficacy mean from the pre-survey administered at the beginning of the

semester was statistically lower than the self-efficacy mean from post-survey 1 administered after the first course exam on the back and upper limb regions of the body; 2) the self-efficacy mean from the pre-survey administered at the beginning of the semester was statistically lower than the self-efficacy mean from post-survey 4 administered after the exam on the head and neck region of the body; and 3) the self-efficacy mean from post-survey 3 administered after the exam on the pelvic and lower limb regions of the body was statistically lower than the self-efficacy mean from post-survey 4 administered after the exam on the head and neck region of the body. In other words, self-efficacy was found to increase between the pre-survey and post-survey 1 when the back and upper limb regions of the body were taught, between the pre-survey and post-survey 4 which encompassed the entire semester and, thus, all regions of the body, and between post-survey 3 and post-survey 4 when the head and neck region was taught. The Cohen's *d* results for these significant comparisons ranged from .28 to .49, indicating an effect between small and medium (Green & Salkind, 2005). These results did support the hypothesis that medical student self-efficacy for the anatomy curriculum would increase significantly at the beginning of the semester. However, it was also hypothesized that self-efficacy would remain unchanged later in the semester, which was not supported by these results.

It was not unexpected to find that self-efficacy increased in the short period of time between the pre-survey administered at the beginning of the semester and post-survey 1, a period which included about three weeks of the Human Anatomy and Embryology course when the back and upper limb regions of the body were taught. Of the 153 students that completed the previous anatomical experience questions embedded in the pre-survey, the mean score the quantity of previous anatomical experiences was 3.75 (sd = 2.39) (range 0-

11) out of a possible 27 points of previous anatomical experiences. Only 6 students reported no previous anatomical experiences prior to medical school and only 9 students reported 1 previous anatomical experience in one of the listed areas prior to medical school. This indicated that most students had some exposure to anatomy prior to medical school, although for most it was not much, as 102 of the students reported a quantity of previous anatomical experiences between 2 and 5 prior to medical school out of a possible 27. Therefore, as the students began the gross anatomy course in medical school, their exposure to the anatomy curriculum, especially through personal mastery experiences, increased significantly. As discussed earlier, an individual's own authentic accomplishments, successes, and mastery experiences provide the most reliable and influential information for accessing self-efficacy (Bandura, 1977, 1986, 1994, 1995, 1997; Schunk, 1991, 2004). Generally, personal successes raise perceived personal self-efficacy (Bandura, 1977, 1986, 1994, 1995, 1997; Schunk, 1991, 2004) by informing the individual that they possess and can utilize the skills needed to be successful at a specific task (Bandura, 1995, 1997).

The first year medical students most likely received some vicarious experiences through interaction with older medical students or others in the medical profession prior to even taking the pre-survey. Vicarious experiences are influential pieces of information when an individual lacks any relevant personal experiences on which to base an evaluation of their own potential capabilities (Bandura, 1986, 1997; Bong & Clark, 1999; Gredler, 1997). However, these vicarious experiences most likely had only minor influence on their self-efficacy, as vicarious experiences by observation of social models (Bandura, 1994) is a source of information that is not as dependable as personal performance accomplishments (Bandura, 1977, 1986). It was not until the first year medical student got into the medical

school dissection laboratory and had their own mastery experiences that their self-efficacy really took root and increased. Additionally, this time in the laboratory also allowed the first year students to see individuals similar to themselves succeed (i.e. vicarious experience information), which makes an individual believe that they too possess the ability to succeed (Bandura, 1986, 1994; Schunk, 2004).

Along these same lines, it is not surprising to observe an increase between the pre-survey self-efficacy from the beginning of the course and the post-survey 4 self-efficacy rating at the end of the course. In other words, most students exited the Human Anatomy and Embryology course in December with a higher anatomical self-efficacy rating than when they entered the course in August. Self-efficacy increased by the end of the semester as the students increased their mastery experiences for the different regions of the body.

It was unexpected for this researcher, however, to find an increase in self-efficacy between post-survey 3 self-efficacy and post-survey 4 self-efficacy. About a month of time elapsed between these two survey administrations. During this month, the students completed the head and neck region of the body. This region of the body is considered to be one of the most difficult regions of the body to accomplish in terms of both dissection and learning, as structures are very small and possess complex architecture. There are convoluted courses of travel for cranial nerves and autonomic nervous system components through the head and neck that must be understood, learned, and intricately dissected by the students. Additionally, these students most likely had little to no previous mastery experiences in this region of the body, as these complex topics are not typically addressed in undergraduate courses. However, the first year medical students would have became quite aware of the complexity and difficulty with this region prior to reaching that portion of the

course, as they would have discovered its difficulty through discussions with older medical students and faculty. Therefore, as the students entered this region of the body, the exposure to it for most would have been only through vicarious experiences and knew it to be an area that could be a significant stumbling block to succeeding in the course.

So, the question becomes why did average student anatomical self-efficacy rise during the time between the post-survey 3 administration and the post-survey 4 administration? There are a number of possible explanations. First, during this time frame of one month between post-survey 3 and post-survey 4, the students had their opportunity for mastery experiences in the head and neck region of the body, instead of only vicarious experiences. It is possible that although the head and neck is considered complex and difficult, the students were able to successfully master the dissections and material, as the students may have been prepared for these dissections and learning through earlier activities in the course that developed their dissection skills and learning strategies. These mastery experiences in the head and neck region then possibly outweighed any negative vicarious experiences, as mastery experiences provided the most reliable and influential information for accessing self-efficacy (Bandura, 1977, 1986, 1994, 1995, 1997; Schunk, 1991, 2004). The second potential explanation of why an increase in self-efficacy was seen between post-survey 3 and post-survey 4 is that the negative hype related to the head and neck region was potentially much greater than its actual difficulty. The student and the faculty always talk about the difficulty with this region of the body, however the question is whether the head and neck region really as difficult as everyone makes it out to be? Is it more difficult to learn or is it just more information to learn? A third potential explanation is that the head and neck region was taught over a longer period of time the other regions, which may have provided

more opportunities for students to develop their self-efficacy (N.A. Granger, personal communication, June 17, 2008). A fourth possible explanation was that more instructors (some of which were practicing clinicians) were available in the laboratories to assist in the teaching of the head and neck region. Due to these additional instructors, the students may have received more feedback and reinforcement during the instruction of the head and neck region than during the instruction of the other body regions (N.A. Granger, personal communication, June 17, 2008). The final potential explanation relates to the timing and/or length of the final survey administration. Post-survey 4 was administered as the students completed their final examination for the course. The survey was located next to the students as they completed this final examination, which covered the head and neck region of the body, and the students were asked to turn in the final survey as they submitted their examination. Students were most likely exhausted when they completed their final survey, but also potentially jubilant that they were now finished with the course. Therefore, this survey likely picked up on not only self-efficacy but additional information as well. The timing of the final survey administration also played into why the response rate was only 71.97%, as it appeared that most students just wanted to get out of the examination rooms and head home. It should also be noted that as the self-efficacy instrument was embedded in larger surveys serving the overall FIPSE grant, surveys over the semester ranged in length from 3 to 6 pages, with this final survey (i.e. post-survey 4) at 3 pages. This long survey length could have also added to the drop in student response rates throughout the semester and especially at the end.

The finding that anatomical self-efficacy increased over the medical gross anatomy course both supports and contradicts previous self-efficacy research findings. As there is no

research in the area of medical student previous self-efficacy for basic science medical coursework, including gross anatomy, comparisons were made to self-efficacy research in the undergraduate forum. Statistical self-efficacy was found to increase by two standard deviations for undergraduate students between the second and last week of an undergraduate introductory statistical methods course where students had no prior formal instruction in the curricular area (Finney & Schraw, 2003). Another study found an increase in computer self-efficacy over a semester-long required introduction to information systems course (Karsten & Roth, 1998). Other studies have found that physics self-efficacy remained the same for college students enrolled in a full year college physics course for non-majors, although when students were divided by academic performance, high-achieving student self-efficacy increased over time while low-achieving student self-efficacy decreased over time (Cavallo et al., 2004). A different study reported that chemistry self-efficacy decreased between week five (i.e. the time of the first self-efficacy instrument administration during the course) and week fifteen for undergraduate college students enrolled in a semester long introductory chemistry course (Zusho, Pintrich, & Coppola, 2003). Finally, a study involving college students in a College English I course illustrated increases in their task-and-skills self-efficacy over the semester, while their writing approach self-efficacy did not change (E. Jones, 2007). These studies show that there are presently mixed results when it comes to self-efficacy changing over the length of courses in different curriculum.

Question 2: Do anatomical self-efficacy ratings predict measures of academic performance (i.e. laboratory practical scores and/or written exam scores) in the medical gross anatomy course, when controlling for academic ability?

To investigate a possible relation between anatomical self-efficacy and academic performance at each of the four exam administrations, hierarchical linear regression analyses were conducted where academic ability, defined as the sum of the Physical Sciences and Biological Sciences MCAT scores, was controlled. Self-efficacy at post-survey 1, which was administered during the first class period following the completion of the first exam covering the back and upper limb regions of the body, predicted the score students received on the lab practical component of this first exam (LP1) in the course, but not the corresponding written exam component (WE1). Self-efficacy at post-survey 2, which was administered during the first class period following the completion of the second exam covering the thoracic and abdominal regions of the body, predicted the scores students achieved on both the lab practical (LP2) and written exam (WE2) components of this second exam in the course. Self-efficacy at post-survey 3, which was administered during the first class period following the completion of the third exam covering the pelvic and lower limb regions of the body, predicted the scores students achieved on both the lab practical (LP3) and written exam (WE3) components of this third exam in the course. Self-efficacy at post-survey 4, which was administered during this fourth and final exam in the course which covered the head and neck region of the body, predicted the scores students achieved on the laboratory practical component of this fourth and final exam (LP4) in the course, but not the written exam component (WE4). In other words, when controlling for academic ability, self-efficacy at/near the time of each exam completion predicted all four corresponding laboratory practicals (i.e. LP1, LP2, LP3, and LP4) and two of the four corresponding written practicals (i.e. WE2 and WE3). More often then not (i.e. six out of eight), these results supported the

hypothesis that the anatomical self-efficacy of the medical students would predict the scores on both the laboratory practical and written exam components of corresponding exams.

The finding that medical student anatomical self-efficacy predicted the academic outcomes, here defined as the laboratory practical and/or written examinations in the Human Anatomy and Embryology course, is similar to previous research findings. For example, a meta-analysis of self-efficacy studies from the 1980's indicated that self-efficacy beliefs accounted for approximately 14% of the variance in academic performances in student in different curriculums from elementary school to college (Multon et al., 1991).

A closer look at self-efficacy research in the undergraduate arena reveals that researchers have found that self-efficacy predicts academic performance at the university level (Andrew, 1998; Klomegah, 2007). However, most if not all research has focused on the prediction of final course grades (Andrew, 1998; Klomegah, 2007) instead of individual exam scores. For example, Andrew (1998) demonstrated that the science self-efficacy of undergraduate nursing students predicted the final score the students obtained in two first-year science courses.

Self-efficacy influences academic performance by acting as one determinate of behavioral and psychological activities (Bandura, 1986, 1997; Britner & Pajares, 2006; Pajares, 1996; Schunk, 1984, 1991; Zimmerman, 2000). These includes choice of activities (Bandura, 1986, 1994; Zimmerman, 2000), effort expenditure (Bandura, 1986; Zimmerman, 2000), persistence (Bandura, 1986; Lent et al., 1984; Zimmerman, 2000), use of cognitive strategies (Pintrich & De Groot, 1990), the use of self-regulatory strategies (Pintrich & De Groot, 1990), and the setting of personal goals (Zimmerman, Bandura, & Martinez-Pons, 1992). In terms of choice in behaviors, individuals will select tasks for which they have

higher self-efficacy, while those with lower self-efficacy tend to avoid tasks believed to be beyond the scope of their capabilities (Bandura, 1986). Although all first year medical students must complete the Human Anatomy and Embryology course, there are still various levels of student participation within the course, especially in the dissection laboratory. As students are divided into dissection groups and only so many members of a group can dissect at any given time, those students with higher anatomical self-efficacy most likely choose to take possession of the dissection tools and complete the dissection for their group. Those students that choose to carry out the dissection more often would most likely receive more mastery experiences then their less active group members, as well as learn additional information especially as it pertains to relationships of anatomical structures in the body. Therefore, this difference in participation could lead to their examination scores being higher, especially when it comes to the laboratory practical portions of the exams.

As mentioned above, there are various levels of student participation within the Human Anatomy and Embryology course, especially in the dissection laboratory. Within a few weeks into course, the students in a dissection group fall into permanent roles within the group. For example, in a dissection group of four students, two students typically become the 'dissectors', while the other two students become the 'readers' of dissection instructions. With this permanent division of labor, two students receive more mastery experiences, while the readers only receive vicarious information watching the dissectors. Therefore, the role of the instructor is to find ways to rotate the division of labor in the dissection group so that one person is not always the 'dissector' or the 'reader'. This would ensure that all students get the opportunity for mastery experiences in anatomy. There are also clinical implications to this rotation of labor, such as dissecting provides the students the opportunity to begin

learning the manual dexterity required to use medical instruments such as the scalpel, scissors, and forceps (Ellis, 2001) and "an appreciation of the strength or fragility of tendons, ligaments, and nerves" (D.G. Jones, 1997, p. 125), that cannot be learned or appreciated through observation.

Question 3: Does a medical student's self-efficacy for the anatomy curriculum at the beginning of the semester predict a student's final score for the course, when controlling for academic ability?

To investigate whether initial anatomical self-efficacy (i.e. self-efficacy at pre-survey) predicted the final score for the gross anatomy course, a hierarchical linear regression analysis was conducted where academic ability (defined by the sum of the Physical Sciences and Biological Sciences MCAT scores) was controlled. The results indicated that the final score for the Human Anatomy and Embryology course was not predicted by the self-efficacy rating at the beginning of the semester. These results did not support the hypothesis that those students with higher self-efficacy at the beginning of the course would have a higher final score for the course than their classmates with lower initial self-efficacy for the anatomy curriculum.

Much of the published research investigating the predictive nature of self-efficacy for final course scores at the undergraduate level do not describe when during the semester the self-efficacy instrument was administered to the student participants when there was only one administration of the self-efficacy instrument. Therefore, previous research in the undergraduate arena with multiple self-efficacy instrument administrations to students during the entire course was reviewed to compare to this present research. The current finding that initial self-efficacy does not predict final score in the course is supported by similar prior

research in the undergraduate arena. A past study by Garcia and Pintrich (1996) investigated self-efficacy of undergraduate students in semester long biology courses, English courses, and social science courses. Self-efficacy ratings were collected twice during the semester for these courses, once within the first two weeks of the course and the second during the last two weeks of the course. It was found that the self-efficacy at the end of the semester accounted for 30% of the variance in the final grades in the courses. However, the self-efficacy at the beginning of the semester did not predict the final course grade, although it was a significant predictor of the final self-efficacy.

The results found by Garcia and Pintrich (1996) are similar to the results found by Zusho et al. (2003). Zusho et al. (2003) administered surveys that included self-efficacy measures to 458 college students in two introductory chemistry courses during the semester at 5 weeks, 10 weeks, and 15 weeks. It was found that self-efficacy at 10 weeks and 15 weeks were significantly correlated with the students' final percentage in the course, while self-efficacy at 5 weeks was not.

These previous results in undergraduate education and the results from this present research indicate that self-efficacy ratings early in the semester tend not to predict the final course score suggesting a time dependency connected to self-efficacy ratings. In other words, these results suggest that when a self-efficacy instrument is used to gauge someone's personal judgments about their abilities to successfully perform a task, the self-efficacy rating should be thought of as only a snapshot in time, as self-efficacy is not static but a dynamic self-belief (Lent & Brown, 1996). After self-efficacy is gauged, the self-efficacy has the potential to remain the same, but it also had the potential to increase or decrease either slowly or quickly, as an individual receives more information from any of the four

sources [i.e. mastery performances, vicarious experiences, social verbal persuasion, and physiological indices (Bandura 1977, 1986)] previously discussed. As indicated by the results of other analyses in this present research study, there was a change in self-efficacy that took place over the course of the gross anatomy semester. This change began immediately at the beginning of the course as the students increased student mastery experiences in the area. Therefore, as self-efficacy changed over the semester, it was logical to find that the initial self-efficacy would not predict the final percentage score for the course. Finally, as these two previous studies (Garcia & Pintrich, 1996; Zusho et al., 2003) found that self-efficacy ratings later in the semester predicted the final score for the course, a future research consideration would be to determine if any self-efficacy ratings obtained later during a medical gross anatomy course would predict the final score in the overall course.

Question 4: When controlling for academic ability, can differences in self-efficacy at the beginning of the medical gross anatomy course be explained by the quantity of prior anatomical experiences?

To investigate whether the quantity of anatomical experiences prior to medical school predicted the initial anatomical self-efficacy (i.e. the self-efficacy rating at the pre-survey), a hierarchical linear regression analysis was conducted, where academic ability (defined by the sum of the Physical Sciences and Biological Sciences MCAT scores) was controlled. The hierarchical linear regression analysis showed that the quantity of previous anatomical experiences prior to medical school predicted the initial anatomical self-efficacy of the MS1 participants (i.e. self-efficacy rating at pre-survey administration). The results indicated that those students with more anatomical experience prior to medical school had higher initial anatomical self-efficacy, while those students with less anatomical experience prior to

medical school had lower initial anatomical self-efficacy. These results supported the hypothesis that those medical students with higher levels of previous anatomical experiences prior to medical school would have higher self-efficacy for the anatomy curriculum, even with academic ability taken into account.

The finding that the level of previous anatomical experiences prior to medical school predicted anatomical self-efficacy of medical students relates to the current understanding of the role of prior experiences in all areas of self-efficacy. As discussed earlier, an individual's own authentic accomplishments, successes, and mastery experiences provide the most reliable and influential information for accessing self-efficacy (Bandura, 1977, 1986, 1994, 1995, 1997; Schunk, 1991, 2004). In one study investigating the sources of science self-efficacy for middle school students, of the four sources of self-efficacy information, only mastery experiences (i.e. prior experiences) significantly predicted the science self-efficacy of the students (Britner & Pajares, 2006). Generally, personal successes raise perceived personal self-efficacy (Bandura, 1977, 1986, 1994, 1995, 1997; Schunk, 1991, 2004) by informing the individual that they possess and can utilize the skills needed to be successful at a specific task (Bandura, 1995, 1997).

The theory that previous experiences play an influential role in self-efficacy has been demonstrated at various education levels, however this is the first study to show that the anatomical self-efficacy of medical students is predicted by anatomical experiences prior to medical school. In the undergraduate arena, a study by Karsten and Roth (1998) investigated computer self-efficacy of undergraduate students enrolled in a required introduction to information systems course. The researchers found that total years of computer experience, current average hours per week of computer use, and the number of prior computer courses

completed were correlated with the computer self-efficacy of the students measured on the first day of the course.

In another study, this one by Prieto and Altmaier (1994), a random sample of graduate teaching assistants in various academic departments at the University of Iowa completed the Self-Efficacy Toward Teaching Inventory (SETI), which accesses the degree to which the individual feels confident in their ability to perform different teaching behaviors. The graduate teaching assistants also completed a demographic questionnaire where they reported previous teaching experiences and the training they received prior to their first graduate teaching assistant experience. Prieto and Altmaier found that the level of self-efficacy was positively correlated with previous teaching experiences and prior training. Additionally, they found that previous teaching experience accounted for 5 percent of the variance observed in self-efficacy. In other words, it was found that those graduate teaching assistants with prior teaching experiences and training had higher self-efficacy than those graduate teaching assistants without these prior activities.

Question 5: Are there gender differences in the quantity of previous anatomical experiences?

ANOVA was used to determine if there were gender differences in the quantity of anatomical experiences prior to medical school. The ANOVA indicated that no statistically significant difference existed between the mean amount of anatomical experiences prior to medical school between females and males students. These results did not support the hypothesis that the female medical students would have fewer previous anatomical experiences prior to medical school than their male counterparts.

As previously discussed, one of the influences of self-efficacy is choice in activities (Bandura, 1986, 1994; Zimmerman, 2000). However, this current research found that although females had lower self-efficacy for the anatomy curriculum than their male counterparts, both genders had the same amount of previous anatomical experiences prior to medical school.

Although females tend to engage in fewer science classes (Kahle & Lakes, 2003), the similarities between the quantity of prior anatomical experiences of male and female incoming medical students may be explained by the reasoning behind why these prior anatomical courses are undertaken by medical students prior to medical school. In a paper by Canaday and Lancaster (1985), the researchers discuss reasons why a student may decide to complete a particular upper-level undergraduate science course that relates to the basic science courses offered within the medical curriculum. The researchers state the students may take a particular course within the undergraduate curriculum because: 1) the student has a genuine interest in the subject matter; 2) the course fulfills the requirements for the undergraduate major, and/or; 3) the student believes that completing the particular course will be an advantage to being accepted into medical school and then succeeding in medical school (Canaday & Lancaster, 1985).

Question 6: When controlling for academic ability, are there gender differences in self-efficacy at the beginning of the medical gross anatomy course?

An analysis of covariance (ANCOVA) controlling for academic ability (defined by the sum of the Physical Sciences and Biological Sciences MCAT scores) was conducted in order to investigate whether gender differences in anatomical self-efficacy exist at the beginning of the semester. It was found that when controlling for academic ability, on

average females had statistically significant lower anatomical self-efficacy at the beginning of the course than did their male counterparts. These results supported the hypothesis that the gender differences in science self-efficacy would still be prevalent at the medical school level and, therefore, female medical students would exhibit a lower self-efficacy than their male counterparts at the beginning of the medical gross anatomy course.

The finding that females entering medical school exhibit lower self-efficacy for a scientific field than their male counterparts is a new contribution to the understanding of self-efficacy, as a gender difference in scientific self-efficacy at this educational level has not been previously reported. This gender difference in anatomical self-efficacy of medical students may relate to an overall societal difference between males and females in terms of science self-efficacy. Gender differences in science self-efficacy have been studied principally at the primary and secondary level, where males report higher science self-efficacy than females (Anderman & Young, 1994; Meece et al., 2006; Tippins, 1991). This same gender discrepancy in science self-efficacy has also been noted at the undergraduate collegiate level (Cavallo et al., 2004).

Female medical students appear to be receiving the same number of opportunities for mastery experiences in anatomy prior to medical school as their male counterparts. However, the female students still develop lower anatomical self-efficacy than the males, even though an individual's own authentic accomplishments, successes, and mastery experiences provide the most reliable and influential information for accessing self-efficacy (Bandura, 1977, 1986, 1994, 1995, 1997; Schunk, 1991, 2004). Although the male and female first year medical students are receiving the same quantity of previous anatomical experiences prior to medical school, they may not be receiving the same quality of previous

anatomical experiences and/or receiving similar mastery experience information from which to gauge their self-efficacy. As discussed previously, the stereotype belief that males are better than females at science is reinforced by primary and secondary schools (Meece et al., 2006; Meece & Scantlebury, 2006). This reinforcement by schools is through multiple avenues including the mode of classroom instruction (Halpern, 2006; Meece et al., 2006; Meece & Scantlebury, 2006), the structure of assessment tools (Halpern, 2006), staffing patterns (Meece et al., 2006; Meece & Scantlebury, 2006), curricular materials such as textbooks (Meece et al., 2006; Meece & Scantlebury, 2006), and classroom interaction patterns (Meece et al., 2006; Meece & Scantlebury, 2006). These differences in science classroom climate have been shown as early as elementary schooling, which have resulted in measurable science achievement level differences in between males and females even by the age of 13 (Kahle & Lakes, 2003). Differences in science classroom climate towards males and females during primary, secondary, and/or possibly even post-secondary schooling, may be leading to medical student females developing and maintaining lower anatomical self-efficacy all the way to medical school.

Self-efficacy has been found to influences choice of activities (Bandura, 1986, 1994; Zimmerman, 2000), effort expenditure (Bandura, 1986; Zimmerman, 2000), persistence (Bandura, 1986; Lent et al., 1984; Zimmerman, 2000), use of cognitive strategies (Pintrich & De Groot, 1990), the use of self-regulatory strategies (Pintrich & De Groot, 1990), and the setting of personal goals (Zimmerman et al., 1992). But gender has also been found to play some role in causal attributions patterns in sex-typed disciplines (Meece et al., 2006). For example, females have been found to attribute more of their failures to lack of ability than their male counterparts in science disciplines (Meece et al., 2006; Ziegler & Stoeger, 2004)

As discussed earlier, when looking at the influence of personal accomplishments on self-beliefs, a relation is observed between Weiner's attribution theory and Bandura's self-efficacy construct. Bernard Weiner's attribution theory (Weiner 1974, 1979, 1985a, 1985b, 1986, 1992; Weiner et al., 1971) considers: 1) how individuals understand and feel about their own success or failure at such things as learning, performance, and goal achievement; and 2) how those understandings and feelings influences future actions (i.e. behavior), such as continuing and enhancing motivation (Driscoll, 2000). When an individual succeeds or fails at a task, the attribution(s) or perceived cause(s) an individual assigns for that outcome is one clue used to judge self-efficacy for that task (Schunk, 1991). In other words, how an individual attributes an outcome, namely as a result of effort and/or the difficulty of the task, will influence their self-efficacy for that task (Schunk, 1991; Bandura, 1997). Typically, when individuals who have failed assign causal attributions for their failure, those with low self-efficacy are likely to attribute failures to a personal lack in abilities, while those with high self-efficacy may attribute their failures to a lack of effort (Bandura, 1986).

As there is a lack of research investigating the causal attributions of medical students for their successes and failures in the medical anatomy curriculum, this research should be undertaken. If female medical students are found to attribute their failures in the anatomy curriculum to their lack of abilities, medical anatomy educators should work to develop methods for attribution retraining (Schunk, Pintrich, & Meece, 2008; Ziegler & Stoeger, 2004), perhaps through modeling techniques (Ziegler & Stoeger, 2004), and assure that they, as instructors, provide accurate attributional feedback to their students (Schunk et al., 2008) in a timely manner.

Question 7: If they do exist, do differences in self-efficacy due to gender and/or previous experiences still exist at the end of the semester, when controlling for academic ability?

As the ANCOVA showed that were differences in anatomical self-efficacy due to gender and as the hierarchical linear regression analysis showed that there were differences in anatomical self-efficacy due to previous anatomical experiences, both when controlling for academic ability, these analyses were repeated with the end of the semester self-efficacy ratings (i.e. self-efficacy rating at post-survey 4) to investigate if those differences in self-efficacy due to gender and previous experiences were still present at the end of the medical gross anatomy course.

When controlling for academic ability, on average females still had statistically significant lower anatomical self-efficacy at the end of the Human Anatomy and Embryology course than did males. These results supported the hypothesis that the gender differences in anatomical self-efficacy would still be prevalent at the end of the semester, with female medical students exhibiting a lower self-efficacy than their male counterparts.

Again, although the male and the female medical students had the same quantity of prior anatomical experiences to medical school, the female medical students entered medical school with lower anatomical self-efficacy. This difference in anatomical self-efficacy between male and female medical students was found still present at the end of the completion of the first year medical anatomy course. This difference may be due to gender differences in competency perceptions that follow stereotypic lines (i.e. girls are better at literacy and writing, while boys are better at mathematics and science), perceptions that are already present by early elementary school (Eccles et al., 1993, 1999; Meece et al., 2006; Meece & Scantlebury, 2006). This difference that still exists between males and females at

the end of the medical gross anatomy course may be also be influenced by the type of causal attributions the female medical students are making about their successes and/or failures within the medical anatomy curriculum. It could also be that females are not experiencing the same mastery experiences in the medical gross anatomy course as their male counterparts, as their lower self-efficacy is causing them to avoid actual dissection and take on more of an observer role in the dissection laboratory. In terms of future research, an investigation should be undertaken to determine whether a correlation exists between anatomical self-efficacy and a student self-selection into the role of 'dissector' or 'reader' within their dissection groups. Additionally, it is also essential that anatomical self-efficacy of medical students be traced through the four years of medical school to determine if there are other points during medical school where changes in anatomical self-efficacy occur and if male and female anatomical self-efficacy ever equilibrate.

The hierarchical linear regression analysis, also part of this research question, indicated when controlling for academic ability, the quantity of anatomical experiences prior to medical school alone did not predict the anatomical self-efficacy of medical students at the end of the semester (i.e. at post-survey 4). Overall, these results did not support the hypothesis that as the semester progressed, those students with lower previous anatomical experiences would continue to have lower self-efficacy for the anatomy curriculum than those students with higher previous anatomical experiences. However, when predicting the self-efficacy at the end of the semester, there was an interaction between prior anatomical experience and academic ability (i.e. MCAT science score), which did predict final self-efficacy. A graph of this interaction indicated that as students had more prior anatomical experience, the relation between MCAT science score and self-efficacy became stronger.

There are a number of potential reasons why the quantity of previous anatomical experience alone no longer predicted the level of anatomical self-efficacy at the end of the medical anatomy course. First, it may be that the concentrated and numerous anatomical experiences available over medical gross anatomy course brought all students, regardless of the quantity of anatomical experiences before medical school, onto an even playing field in terms of their exposure to mastery experiences so that they could judge their self-efficacy with the most reliable and influential information for accessing self-efficacy (Bandura, 1977, 1986, 1994, 1995, 1997; Schunk, 1991, 2004). Secondly, it may be that because of the reduction of survey responses by the end of the semester, the study became underpowered and thus was unable to demonstrate a significant predictive nature of anatomical experiences prior to medical school for medical student anatomical self-efficacy at the end of the medical gross anatomy course. Lastly, as previously discussed, the timing and/or length of the final survey administration may have made the self-efficacy report from the students confounded. As post-survey 4 was administered as the students completed their final examination for the course, most students were likely exhausted, excited about the course ending, and/or just wanting to leave the final exam administration rooms. This could have influenced their responses, as well as the response rate. In the future, a different administration time for the final self-efficacy survey should be scheduled.

It should be noted that *t* tests were conducted to compare the demographics of those students that completed post-survey 4 to those students that did not complete this final survey. Those students that did not complete the final survey were found to be the same as those students that completed the final survey in terms of age, quantity of previous anatomical experiences, and MCAT science scores. However, the group of students that did

not complete post-survey 4 were predominately male (~66%), scored statistically significantly lower on LP1, WE1, LP2, WE2, LP3, and LP4, and also received a statistically significantly lower final course grade. This change in the sample of students (i.e. a loss of lower achieving students) may have led to the differences observed at the end of the semester.

Future Research

Further Research on Undergraduate Coursework's Influence on Anatomy Self-Efficacy of Medical Students. Currently, gross anatomy is not a requirement for admission into medical schools in the United States, Canada, or the Caribbean. For example, during the 2005-2006 academic year, completion of an anatomy course was not required for admission to the 142 accredited medical schools in the United States, Canada, or the Caribbean (AAMC & Moller, 2004; Peterson & Tucker, 2005). Many premedical students, however, select an undergraduate science major (Canaday & Lancaster, 1985; Forester et al., 2002; Hall & Stocks, 1995) and/or complete undergraduate courses whose content will be addressed again in medical school (Canaday & Lancaster, 1985; Forester et al., 2002), like anatomy. These courses that will be encountered again in medical school are completed by premedical students as undergraduates with the expectation of improving their academic performance once in medical school (Canaday & Lancaster, 1985; Forester et al., 2002). Although having a science undergraduate major versus a non-science undergraduate degree has not been shown to predict medical school success (Canaday & Lancaster, 1985; Dickman, Sarnacki, Schimpfhauser, & Katz, 1980; Forester et al., 2002; S. R. Smith, 1998; Yens & Stimmel, 1982), a number of research investigations have found that previous exposure to anatomy prior to medical school is correlated with success in medical gross anatomy (Canaday &

Lancaster, 1985; Forester et al., 2002; Peterson & Tucker, 2005) or its subdisciplines (Canaday & Lancaster, 1985; Forester et al., 2002). These research efforts support the argument of Canaday and Lancaster (1985) that when investigating predictors for medical school success, it is important to not to focus on the declared undergraduate majors, as non-science majors complete science courses some of which are very similar in course name and/or descriptions to those offered within the basic science component of medical schools.

Peterson and Tucker (2005) investigated the role of undergraduate anatomy coursework in the predication of medical anatomy success. These researchers found that medical students who took at least one anatomy-related undergraduate course were higher in class rank in medical anatomy than their classmates who did not take undergraduate anatomy. When divided by type of undergraduate anatomy course(s) completed, the undergraduate anatomy experiences that showed this positive correlation were human gross anatomy and anatomy laboratory courses, while anatomy and physiology, kinesiology, or comparative vertebrate anatomy did not correlate with a higher class rank in medical anatomy.

In another study, Forester et al. (2002) investigated the role of undergraduate coursework in anatomy in predication of osteopathic medical anatomy success. These researchers found that those students with premedical anatomy and histology [i.e. a subdiscipline of anatomy that studies the microscopic structure of tissues (Tortora & Derrickson, 2006)] coursework earned a significantly higher number of points in medical anatomy and histology, respectively. When looking at the type of premedical anatomy coursework, those medical students that completed an undergraduate course with prosection (i.e. prosection is where the student studies the finished dissected product instead of

performing the dissection themselves) earned a significantly higher number of points in the medical anatomy course.

The results of Forester et al. (2002) were partially observed in earlier research by Canaday and Lancaster (1985). Canaday and Lancaster found that medical students with previous experience in undergraduate histology received higher grades in medical histology. They found, however, that only first MCAT quartile medical students with previous experience in undergraduate anatomy received higher grades in medical anatomy, demonstrating that prior experience benefits may be linked to academic ability.

It is likely that self-efficacy was a factor that played a role in this earlier research Canaday and Lancaster (1985), Forester et al. (2002) and Peterson and Tucker (2005) that linked previous experiences in undergraduate anatomy with subsequent success in medical gross anatomy. Based on the findings presented here, the students in the Canaday and Lancaster (1985), Forester et al. (2002) and Peterson and Tucker (2005) studies with previous undergraduate anatomical experiences most likely had higher self-efficacy than their counterparts without previous undergraduate anatomical experiences. As the research presented here on medical student self-efficacy for the anatomy curriculum is a new contribution to self-efficacy research, it must be further investigated. Specifically, an examination into whether the type of undergraduate anatomy courses completed influences the level of medical student anatomical self-efficacy needs to be undertaken. This investigation could be vital to a better understanding of anatomical self-efficacy development, as well as lead to the possible reform of medical school requirements and/or recommendations for admission.

Medical Student Self-Efficacy for Anatomy and its Possible Influence on Residency Interest. Females now compose one half of all medical school enrollments in the United States (AAMC, 2007; Evans & Sarani, 2002; Halpern, 2006; U.S. Census, 2001; Wendel et al., 2003), although at some medical schools females are the majority (Wendel et al., 2003). This is a significant gain for females over past years. For example, during the 1961-1962 academic school year, females only made up 6.3% of the total enrollment and 5.5% of the total graduates at U.S. medical schools (AAMC, 2007). However, by the 2005-2006 academic school year, females made up 48.8% of the total enrollment and 47% of the total graduates at U.S. medical schools (AAMC, 2007). Of the applicants to U.S. medical schools for the 2007-2008 academic school year, 49.0% or 20, 734 were female, the largest number of females ever applying to U.S. medical schools in an academic year (AAMC, 2008). Of the graduates of U.S. medical schools during the 2007-2008 academic school year, 49.1% or 7,922 were female, the largest proportion and number of females earning a M.D. in any one academic year (AAMC. 2008).

Although females have made significant strides in terms of numbers of applicants and graduates within U.S. medical schools (AAMC, 2007, 2008), there still exists a significant shortage of females in what are considered male-dominated medical professions, such as surgery (Evans & Sarani, 2002; Magrane et al., 2007; Wendel et al., 2003). The percentages of female residents in surgical areas in 2006 were 31.0% in colon and rectal surgery, 10.9% in neurological surgery, 11.5% in orthopaedic surgery (including subspecialties), 23.7% in plastic surgery, 29.8% in general surgery, 17.8% in general surgery subspecialties, and 11.8% in thoracic surgery (Magrane et al., 2007). Although still not equal to the male involvement, this is an increase over the percentages of female residents in these same

surgical areas in 1996, with the 1996 female residents composing 17.0% of the residents in colon and rectal surgery, 9.1% of the residents in neurological surgery, 7.3% of the residents in orthopaedic surgery (including subspecialties), 16.5% of the residents in plastic surgery, 19.3% of the residents in general surgery, 11.6% of the residents in general surgery subspecialties, and 5.4% of the residents in thoracic surgery (Magrane et al., 2007). Although there is this divergence between the numbers of female and male residents in surgical areas such as general and plastic surgery (Magrane et al., 2007), Minter, Gruppen, Napolitano, and Gauger (2005) found that the performance of female and male general and plastic surgery residents is equivalent. However, Minter et al. (2005) also found that the female residents in a general and plastic surgery residency program at one location underestimated their skills to a greater degree than their male counterparts, although this difference was not statistically significant possibly due to the tests being underpowered because of the low number of residents at the research location.

An understanding of anatomy is important to the practice of medicine (Dinsmore et al., 1999; Education Affairs Committee, 1996), but it is especially the case in surgery (Cottam, 1999). A survey of residency programs across the United States found that radiology and general surgery residence programs assigned statistically more importance to gross anatomy for the mastery of their discipline than did residency programs in emergency medicine and family practice (Cottam, 1999). More specifically, 74% of the 224 surgical residency programs reported that a sound gross anatomy knowledge was ‘extremely important’ to the mastery of their discipline, which was the highest possible response (Cottam, 1999). Of the remaining 224 surgical residency programs, 25% responded ‘very

important' and 1% reported 'somewhat important' when asked about the importance of gross anatomy knowledge to the mastery of their discipline (Cottam, 1999).

As self-efficacy has been show to play a role in selection of career choices (Betz & Hackett, 1981; Lent & Brown, 1996; Lent, Brown, & Hackett, 1994; Lent, Brown, & Larkin, 1987) and a solid knowledge of gross anatomy is vital to the mastery of surgery (Cottam, 1999), it is possible that anatomical self-efficacy is playing a role in the choice of medical specialization. Therefore, it is critical to investigate whether anatomical self-efficacy predicts the selection of a medical specialty during the fourth year of medical school. As this research study has shown that females have lower anatomical self-efficacy at the end of the first year medical anatomy course, this may be one factor contributing to the actuality that women still only compose a small percentage of surgical residents (Magrane et al., 2007). The need for this research was alluded to by Minter et al. (2005) who stated the following:

> If we hope to attract more women into the field of surgery so that increased representation can be achieved, it is critically important that we better understand the current obstacles and potential reasons that women do not choose surgery as a career. An inaccurate self-assessment of their ability to succeed in surgery may be one of the reasons that female medical students do not choose surgery as a career. Clearly, if we hope to attract more women into the field of surgery, consideration of the many factors affecting their choice will be important, but the perception that surgery is a field in which they can be successful will certainly be a critical component of their decision-making process. (p. 650)

Although Minter et al. (2005) never stated the word 'self-efficacy' in the body of their paper, what these researchers were alluding to was the idea that self-efficacy was influencing the career choice of most female medical students not to enter a surgical career. Therefore, it is vital that this proposed research be undertaken in the near future to better understand student selection of medical specialties and possibly why women tend not to select surgery as their medical specialty.

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