Learning in Medical School: Relationships Among Achievement Goals and Approaches to Learning in Three Classes of Medical Students

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LEARNING IN MEDICAL SCHOOL: RELATIONSHIPS AMONG
ACHIEVEMENT GOALS AND APPROACHES TO LEARNING
AND STUDYING IN THREE CLASSES
OF MEDICAL STUDENTS

BY

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DISSERTATION
Submitted in Partial Fulfillment of the
Requirements for the Degree of
Doctor of Philosophy
Educational Psychology

The University of New Mexico
Albuquerque, New Mexico

August, 2011
Dedication

With Much Love and Appreciation

To my Grandparents
(...the first Americans in my family)

Gertrude Koch Houghton
Ernest Alfred Houghton, Sr.
Roza Kobor Pecze
Andrew Pecze

And

My Parents

Eleanor Elizabeth Pecze Houghton
Ernest Alfred Houghton, Jr.
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ABSTRACT OF DISSERTATION

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Medical student learning behaviors were examined in terms of achievement goals and approaches to learning. First, second, and third year medical students completed a Questionnaire composed of three extant inventories, the Achievement Goals Questionnaire (AGQ), the Metacognitive Awareness Inventory (MAI), and the Approaches to Learning and Studying Inventory (ALSI). Performance and demographic data were analyzed in terms of Questionnaire subscales. Of the three measures, two produced moderate to high reliability values. The MAI produced low reliability values and a high number of EFA factors resulting in discontinuation of analyses for that measure. Students holding mastery-approach achievement goals are more likely to monitor their study, engage in deep learning strategies, manage and organize their study effort. Performance-approach achievement goals are also associated with deep learning strategy, monitoring, organizing, and managing study effort.
Performance-avoidance and mastery-avoidance achievement goals are associated with surface learning strategies. Younger students at matriculation and first year students are more likely to hold mastery-avoidance achievement goals. Female students are more likely to manage their study effort and organize their studying. The approach dimension of performance achievement goals showed a positive relationship with medical school GPA while the avoidance dimension showed a negative relationship.
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Introduction

Medical school is transformational. From career changers to long time devotees of the profession, this educational path demands dedication, adaptability, determination, as well as excellent cognitive ability. Once this path is chosen and the prerequisite coursework, clinical experience, and application materials are completed, and acceptance into a medical program materializes, what happens next? What learning methods, skills, and processes are relevant to the new learning environment of medical training? Medical school is transformational because of a deep engagement with multiple levels of cognitive, affective, and behavioral dimensions of learning, and the subsequent changes that emerge in thinking, understanding, and skill building. This study examines one aspect of how this transformation unfolds for trainees. That is, what can students’ self proclaimed learning goals and approaches to learning and studying in medical school tell us about this complicated and transformative learning experience?

Medical education is a discovery process involving the mastering of ever more complicated, integrated, and applied levels of knowing. Similar to other graduate programs, learning in medical school is a dynamic process, and is situated in a unique instructional environment which informs students’ choice and emphasis in learning methods. Learners employ particular goals and approaches to learning which they interpret to be the most effective given the particular instructional environment.

As background and context for the exploration of medical student’s goals and approaches to learning, I review major curriculum changes in medical education over the past 60 years. These curricular models each impacted student learning processes and were developed in part through current educational and cognitive psychology research and theory.
Research shows that systemic curricular changes can significantly alter the learning environment (Brown, 2002; Richardson, 2002), therefore creating different learning challenges for each cohort of students learning in a different curricular model. Perceptions of learning environment can be especially crucial for some students' motivation, comfort, and perceptions related to potential for success in a particular environment (Mayya & Roff, 2004). These curricular models are presented as context for exploring medical student learning processes through the lens of their goals and approaches to learning.

The initial chapter begins with a description of medical education in general, continues with descriptions of major curricular models, and challenges for medical students and educators. Following the wider medical education context, is the theoretical and more specific construct level from educational psychology research. This is followed by a selection of academic and learning support interventions that have been implemented and reported by medical educators. Finally, in an integrated approach, the learning environment of medical education is addressed within the conceptual framework of educational psychology research and theory. The resulting study explored the relationships among the particular constructs of achievement goals for learning, metacognitive monitoring, and approaches to learning and studying.

This investigation surveyed a group of current medical students to discover how these three constructs operate in the students’ learning processes, and to see if there is a difference in student responses relative to their year in training. This kind of inquiry has relevance for medical students and medical educators, as circumstances leading to curricular change, and challenges for medical student learning in a complex learning environment have not diminished.
Review of Literature

Medical Education Curricular Context

The main components of medical training: premedical coursework, undergraduate medical (medical school), graduate medical (residency), and continuing medical education are constants in most medical education programs (Bloom, 1988; Burns, 1975; Spencer & Jordan, 1999). In the U.S. most students complete four years of undergraduate college education including specific prerequisite courses (2 semesters of biology, chemistry, organic chemistry, physics, one semester biochemistry), completion of the Medical College Admissions Test (MCAT) (verbal reasoning, physical science, biological science, essay), then four years of medical school, generally two years of clinically oriented basic science (pre-clerkship education) and two years of clinical practice (clinical education), graduation with the medical doctor degree (MD), followed by 3-7 years of graduate medical education. This is where students develop professional level specialty skills training, for instance, Family Medicine, Internal Medicine, Pediatrics, Surgery, or Emergency Medicine. Throughout medical training students complete three steps of the United States Medical Licensing Exam (USMLE), Step 1 and Step 2 during medical school and Step 3 during their first year of residency (intern year). Six year medical training programs are also known, and are most prominent outside the U.S. but include several U.S. schools (Dimond, 1988; Olson, 1992). Standards for medical education are established in the three areas of content, assessment, and process (Wojtczak & Schwarz, 2000).

Learning Environment – Medical Education

To attain an expert level of medical practice, for most of medical education history, students apprenticed with a practicing physician until they reached a level of integration of
science and clinical skills that warranted independent practice. There were variable pre-
clinical science requirements in order to apply and secure an apprenticeship position, but 
building clinical skills through interactions with patients was the main focus of training. 

Following the apprenticeship model, several dominant trends have been apparent in medical 
education in the 20th century: the basic science model, the organ system model, the problem-
based learning model, the clinical-presentation model, and team-based and task-based 
learning models. These curricular trends are used primarily in the first two years, or pre-
clinical years of medical training, although there is overlap into clinical training at some 
schools.

**Basic Sciences Model of Medical Education – A faculty-centered paradigm.** 

Prior to the mid 20th century a medical student typically started at one of the 155 US and 
Canadian medical schools with a newly minted bachelor’s degree in biology, chemistry, 
ocasionally engineering or social science, anticipating another two years of basic science 
instruction as a segue into clinical training for their medical career. Fellow students in the 
first year class would have shown a comfortable familiarity if they were male, white, middle 
or upper class, grew up in the U.S., perhaps with a physician in the family. A faculty-
centered lecture-based learning environment was the norm, offering a high comfort level for 
faculty and students alike; students’ pre-medical training anticipated and largely prepared 
students for this medical school learning environment. Courses were organized according to 
the basic science disciplines of Anatomy, Physiology, Microbiology, Biochemistry, 
Immunology, Pathology, Pharmacology, Embryology and Behavioral Science.

**Impact on students.** Students were hardworking but passive recipients of 
information; they were guided in their learning and studying with faculty generated course,
lecture, and lab outlines, schedules, and assignments, with mostly multiple-choice, fact based exams (Gwee, 2003). Each course and often lectures were independent of one another, and presented sequentially rather than in an integrated manner through the curriculum. Students completed two years of basic science course work, and then proceeded into two years of clinical training. Following a lecture-based format, students weighed the need for deep learning against time constraints and often relied heavily on memorization techniques to navigate the learning material and study for exams (Gwee, 2003).

**Challenges with the Basic Science Based Model.** Although this model provides a good way to present significant amounts of factual information, it can limit students' ability to integrate their knowledge because of the large volume of information presented in each course, the fast pacing through an extensive curriculum, and the practical need for memorization over deeper levels of learning. Additionally, lecturers tended to teach to students in large lecture halls, without instructor's attention to the different ways students learn or the differences in student's learning and processing modes and timing (Kanthan & Mills, 2005). Because students do in fact have different learning styles and pre-medical preparation, this model can be challenging for some students.

**Organ System Based Model of Medical Education – A faculty-centered paradigm.** Students in the 1950s may not have been aware of it, but as they entered medical school substantial changes were taking place in U.S. medical education. Curricular changes signaled a reorientation away from a basic science-discipline based education, used since the 1870s, to a new organ system based education (Mandin, Jones, Woloschunk, & Harasym, 1997; Papa & Harasym, 1999). The organ system model was designed to consist of courses whose focus was systems-based, rather than discipline-based. Although configured
somewhat differently in each medical school, generally medical systems include: Organ Systems, Immunology, Microbiology, Infectious Disease, Cardiovascular, Endocrine, Gastrointestinal, Hematology and Oncology, Musculoskeletal and Connective Tissue, Neurology, Renal, Reproductive and Respiratory. The reorganization had substantial impact in medical schools by moving the center of course control from the distinct basic sciences to a more overtly integrated instructional approach (Papa & Harasym, 1999). The faculty-integrated organ system based curriculum was in direct contrast to the discipline based system, where students were expected to integrate the basic science course work independently as they gained experience during the clinical rotations beginning in their third year. The rationale for moving toward an organ system instructional approach was exactly to facilitate this integration of basic science knowledge into clinical practice from an expert’s vantage point. Integrating a complex, multi-faceted curriculum has long been the intent and challenge for medical educators. One school, for example, uses this approach to integrate pharmacology instruction using a multidisciplinary method within the organ-system based curriculum (Faingold & Dunaway, 2002).

**Impact on students.** Under the organ systems-based curriculum, students were still mainly guided in their learning by course and lecture outlines, lecturers, and laboratory assignments. However the distinctness of the basic science courses gave way in favor of an approach of teaching from the integrated functional perspective based on the body’s organ systems. Students were able to study the application of their knowledge earlier in their training, and begin to orient toward the clinical aspects of medicine.

**Challenges with the Organ System Model.** The organ systems-based curriculum was eventually judged inadequate to the extent that some students were not performing in clinical
rotations with the expected level of integrated scientific understanding (Papa & Harasym, 1999). The vital component may have been that although basic sciences were integrated into an organ systems approach, the cognitive integration activity was still being done by the faculty members. There was much for students to learn, but the integrative strategies and clinical reasoning practices were underdeveloped, possibly because this work was being done by the expert faculty rather than the novice students. Students were better able to understand the body as a functional unit, but the integration of knowledge remained with faculty instructors and students continued to have a fundamentally passive role in their medical education. Clinical training remained the focus of the final two years of training, and only after two years of organ systems-based basic science education.

**Problem-based Learning Model of Medical Education – A student-centered paradigm.** By the 1970s, a new medical student was still likely a fresh baccalaureate, but now joined the first year class along with a few students holding graduate degrees or having already worked in a variety of fields. A quick survey of this class would reveal a good number of female students, as well as a growing number of underrepresented minority (URM) students. Medical educators were again revisiting the medical curriculum, as the innovations of the prior 20 years had not answered all the academic curricular concerns as intended and suggested an unmet need for an instructional approach that helped students develop their clinical problem-solving abilities. Active, student-centered, self-directed learning approaches were introduced in the 1970s, with the problem-based learning (PBL) approach in particular developed to address this issue (Boud & Feletti, 1999; Kaufman, 1985). The PBL model proved successful in a medical school context using small group
PBL became a widely-adopted instructional innovation in medical education and other programs in higher education, graduate and professional education programs (Alper, Rendel, Fraser, & Resek, 1998; Bridges & Hallinger, 1998; Cawley, 1999; Maitland, 1999). As a curricular model, PBL draws heavily from cognitive science with an emphasis on active learning, and in creating a constructivist, student-centered learning environment (Boud & Feletti, 1999; Fogarty, 1998; Kaufman, 1985; Mandin, et al, 1997; Savery & Duffy, 1998; Swartz, Mennin & Webb, 2001). PBL’s self-directed learning paradigm encourages students to develop their ability to think critically, link new information to prior knowledge, to learn in context, to use group discussion as a learning tool, and to rely on instructional scaffolding only when necessary.

There are six traditional steps, based on the scientific method, used in the PBL process to achieve these objectives (Delisle, 1997; Engel, 1999; Fogarty, 1998; Schwartz, et al, 2001). These six steps, also known as the clinical reasoning process, are described by Lucero, Jackson, and Galey (1985, p. 48):

1. Identify problems
2. Generate hypotheses of a) causes; and b) mechanisms by which causes create problems
3. Rank hypotheses
4. Test hypotheses with a) current data and knowledge; b) new data and knowledge
5. Re-rank hypotheses (most likely hypothesis is tentative diagnosis)
6. Treat (to manage problems)
A faculty tutor (optimally one basic scientist and one clinician educator) guides the students through this learning process, encouraging them to identify and prioritize their own learning issues. Not unlike earlier models, PBL students are taught to identify healthy human structure and function, mechanisms of disease, procedural and technical processes used to treat illness, and the effects and side effects of clinical tests and procedures. However, here students learn in the small group tutorial, with study partners and individually, to research and incorporate learning issues with limited guidance from their more expert faculty tutor. The tutor maintains group cohesion and functioning, focusing the discussion on important aspects of the clinical problem (clinical case), answering technical questions to move the discussion along, and through scaffolding move students toward integration of basic and clinical science as they explain the medical processes in the case study. The self directed nature of PBL tutorial groups shows some variation, with additional structure added to some formats to purposefully guide students and thereby deepen their understanding of the case based biological and population core issues (Espey, Ogburn, Kalishman, Zsemlye, & Cosgrove, 2007).

**Impact on students.** PBL tutorials engage students in active learning, with the intent and potential for deeply learning the information presented, as well as developing critical thinking skills (Tiwari, Lai, So, & Yuen, 2006). Active learning through PBL does not automatically lead to deep learning but does have greater potential than the lecture-based format, nor does it necessarily help students develop positive self regulation skills (Evensen, Salisbury-Glennon, & Glenn, 2001). Additionally, when learning in small groups students are more exposed and more subject to the operational precision and quality of the particular small group than in lecture format (Dolmans, Wolfhagen & van der Vleuten, 2001). Quieter
students, or those with slower processing times may find the pacing too fast, or too extroverted for their optimal learning comfort. Furthermore, learning environments which highlight a student’s intellectual and verbal abilities, such as small group tutorials, also have the potential to activate stereotype threat in some students (Carr & Steele, 2009; Smedley, Butler & Bristow, 2004), which can work against problem solving behaviors and lead to inflexibility in perseverance (Carr & Steele, 2009); or could challenge certain student’s personal or cultural temperament in ways that make learning in this context and environment more difficult (Forrest & Walsh, 2001; Kaufman & Mann, 2001). A student’s comfort with their learning environment speaks directly to their ability to establish and maintain their goals for learning and approaches to learning in that environment.

**Challenges with the PBL method.** The classic PBL reasoning process trains students to learn general problem solving skills that can be applied to other cases or situations (Engel, 1999; Mandin, et al, 1997). Despite the wide popularity of PBL curricular models throughout the 1970s and 1980s, by the early 1990’s, some medical schools were noting disappointing trends in medical students’ clinical problem solving abilities (Papa & Harasym, 1999). The PBL method attempts to train students (as novices) to think critically and integrate basic and clinical science by working through clinical case studies to develop their patterns of critical thinking and problem solving skills. This process guides students to learn general clinical analytical thinking that can be applied to a variety of different cases. It is possible, however, in this hypothetical-deductive approach that students could develop a “backward reasoning” orientation to clinical problem solving (Mandin, et al., 1997; Papa & Harasym, 1999; Schon, 1983). The PBL reasoning process actually contrasts with that of expert clinicians who tend to use a “forward reasoning” orientation in ”broader, problem- and
disease-class-specific, highly structured, knowledge-based schemes” (Gilhooly, 1990; Papa & Harasym, 1999, p.160). That is, expert clinicians tend to collect data and move toward one final hypothesis by a system of discounting and displacing hypotheses until one that works is identified. Therefore, diagnostic expertise is not dependent on general problem solving skills, but rather on a strong knowledge base and a systematic way to categorize and organize specific information for each presentation (Papa & Harasym, 1999). Experts have learned to organize a knowledge base into practical and accessible “schemes” (used interchangeably with schema) that can be called upon strategically when solving a clinical problem. Further, there is some criticism that discovery learning methods, especially when instructors do not offer adequately specific guidance during the learning process, are ineffective in helping students develop appropriate cognitive architecture or schemes (Kirschner, Sweller, & Clark, 2006). This model also necessitates capital resources in the form of numerous small rooms to accommodate the group work (Stringer, 2002), as well as faculty to serve as tutors for each small group.

Clinical Presentation Model of Medical Education – A student-centered paradigm. Attempts were made to address these issues in the 1990s with the clinical-prresentation (CP) model. Contrasting with the general-to-specific problem solving models, in CP the premise is that experts drawn upon highly organized knowledge-based schemes on a case by case basis beginning with patient data and moving forward to hypothesis (Higgins & Tully, 2005). The CP model is designed to help students with their knowledge organization by helping them develop a case based reasoning process (Mandin, Harasym, Eagle, & Watanabe, 1995; Mandin, Jones, Woloschunk, & Harasym, 1997). The CP instructor could be seen as more directive in instructional style, in contrast to the more
facilitative role in helping students to identify their own learning issues, as seen in PBL. The CP instructors directly coordinate and organize the resources students are expected to need to learn the material. Mastery of basic science concepts in a specific clinical context is the primary driving force in this model, rather than general problem-solving ability. In CP, clinical cases are used to present the basic complaint (chest pain, headache), but in contrast to PBL, rather than guiding students to identify and then research their self identified knowledge gaps by establishing learning issues, the instructor takes an active role in outlining and teaching specific pre-planned schemes that students are expected to learn in the context of the particular case under study (Mandin, et al., 1995; Mandin, et al., 1997; Papa & Harasym, 1999). Faculty members, as identified experts, develop and demonstrate these schemes that describe the critical thinking and clinical reasoning process that they would use in the clinical problem presented.

Papa and Harasym (1999) emphasize three steps in building a CP curriculum: first, create terminal performance objectives which are then used to create corresponding basic science knowledge objectives; second, establish a close connection between students’ performance and their basic science knowledge base; and third, create enabling objectives, the knowledge, skills, and abilities that students need to master to achieve the terminal objectives. These steps are used to develop an instructional process, which is described by Papa and Harasym (1999), as follows:

1. An instructor provides the context by outlining the schema relevant to the clinical presentation under study
2. The instructor demonstrates use of schemes in contextual problem solving
3. Lectures are provided which cover relevant and related basic & clinical science
4. Students participate in a small group PBL session to practice solving cases using the presented schemes

The CP curriculum model is intended to help students early in their medical education to gain capacity in building cognitive structures with their growing knowledge base, to be able to later retrieve needed information from the complex, interconnected levels of understanding needed for solving clinical problems. Clinical Problem Analysis (CPA) is a more clinically oriented version of CP, designed as a training tool for solving complex clinical problems (Custers, Stuyt, & DeVries, 2000). CPA uses a four-step structured reasoning process which incorporates patient history, physical exam, lab analyses, differential diagnosis, and lastly an action plan (Custers, et al).

**Impact on students.** The Clinical Presentation (CP) model also engages students in active learning, with the intent of deliberately helping students to develop knowledge schemes, as organized mental representations of new information. Not only are students expected to deeply learn the basic and medical science foundational information presented, but this method of teaching and learning is expected to also help students retain and retrieve this information in a more organized manner in clinical settings. Part of this scheme development is knowing the content but also knowing the application, this is the cognitive reasoning ability of experts that the model is intending to instill in students. Many of the small group learning issues are also present in this model, as similar to PBL tutorials, CP sessions are held in small groups with a tutor/instructor leading the session.

**Challenges with the Clinical Presentation Model.** CP is a relatively new instructional model for medical education. To ensure that students learn at sufficient depth the CP sessions are highly structured, coordinated and actively taught by faculty. Clinical
presentation sessions are constructed around specific and structured problem sets, and within each clinical problem a scheme designed by expert faculty is taught to help students conceptually organize the new information, and to help them work through solving the clinical problem (Mandin, Harasym, & Woloschuk, 2000). Faculty experts write terminal objectives that will facilitate students’ development of schemes for resolving clinical problems; and this is conceived as a developmental process as students gain experience and expand their knowledge base. Curricular challenges might include time and resource intensity, at least at the developmental stages, along with full school buy in and interest. This is also, a room resource and faculty intensive model (Stringer, 2002).

**Team Based Learning Model of Medical Education – A student-centered paradigm.** In contrast to the instructor guided CP model, in the Team Based Learning (TBL) model students research and learn the course content based on well delineated learning objectives, and are given wide latitude in constructing, researching, and mastering the material. In TBL, once a learning group has transformed into a functional team (this takes purposeful planning, work and timing similar to high performance team work known in the business world) they are expected to operate at a more advanced level of learning than would happen individually (Michaelsen, Knight, & Fink, 2004). Courses are compatible with this instructional model if the course contains significant amounts of content that students need to fully understand, and students need to learn how to apply knowledge of the course content through solving problems (Michaelsen, et al).

Parmelee, DeStephen, and Borges (2009, p. 1) describe five essential components of the TBL instructional model:

1) Advanced preparation (instructor defined, student prepared);
2) Team formation (assigned teams of 5-7 students);

3) Readiness assurance (individual quiz score, then group completes the same quiz and earns a group score);

4) Group application exercise (all teams work on the same learning objectives or problems to solve);

5) Peer evaluation (of each team member’s contribution to the group functioning).

In TBL, group process is very important for proper functioning and learning, students must be held responsible for learning and feedback must be useful as well as timely (2004). Another version of TBL is Task-based Learning, used more often in clinical training than in pre-clinical classrooms (Harden, Laidlaw, Ker, & Mitchell, 1996). Akin to the CPA model, Task-based Learning focuses on clinical practice tasks, and requires students to understand the concepts and mechanisms involved in completing the task. Therefore, understanding the underlying actions is as important as learning how to perform a certain task (Gupta, Kumkar, & Shah, 2003).

**Impact on students.** The wide latitude for organizing, coordinating resources, and self-assessment and monitoring of learning that is granted to students in the TBL model may challenge some student’s confidence to learn. At the same time, other students seem to thrive in this learning environment of high personal autonomy. The reduction in lecture time suits many students at this level of training, but not all. Despite the autonomy of learning technique and timing of answering learning objectives as described by the instructor, there remains a high level of personal and group level accountability for the material to be learned (Parmelee, et al., 2009). Similar to any instructional model, faculty members design their
TBL courses along a continuum of more or less structure, process guidance, coaching, and accountability.

**Challenges with the Team Based Learning Model.** TBL is also a relatively new instructional model, implemented in medical schools in the early 2000s. Similar to any instructional model, a quality learning environment is dependent on a number of factors, beginning with the instructor. Groups of students may not actually advance into high functioning teams if the requisite trust and motivation to develop in this learning model does not fully develop. Students must understand the learning objectives and have the knowledge and motivation to answer the objectives independently with enough thoroughness to fully understand the material and to add to the group discussion when the team meets. The ideal of well integrated course information may not be met if the qualities of a functioning team do not materialize and if individual students cannot adapt to the rigors of self selection of course materials and resources related to understanding the objectives.

**Current Medical Education Learning Environment**

Despite the educational, scientific, and social changes taking place in the last half of the 20th century, the basic skills practicing physicians needed to acquire did not change significantly. Curricular methods reflected the best practices of medical education at the time they were implemented. By the turn of this century, the first year class of medical students is nearly 50% female, and often 10-15% underrepresented minority (URM) (AAMC, 2009). Students who entered medical school in 2000 may or may not encounter a learning environment compatible with their undergraduate educations in basic science (biology, chemistry, biochemistry, physics), engineering, computer science, social science, nursing, EMT and other technical fields. At many of the 125 medical schools in 2000, students were
exposed to clinical experiences and patients early in the curriculum, often during the first two years (Anderson & Kanter, 2010). The 132 medical schools affiliated with the Association of American Medical Colleges (AAMC) in 2010 offer a range of curriculum models, most with some version of a “hybrid” curriculum, which is a combination of lectures, laboratory work, and a version of group learning. Additional coursework is often added in public health, population medicine, and/or community-based clinical and other experiential learning situations (Sales & Schlaff, 2010). Although critics argue that students still need more empowerment and a decision making role in the medical curriculum (Rees, 2004).

Calls for curricular change continue, for instance, integrating student-patient interactions directly into the curriculum as real patient-centered medical education. As described by Bleakley and Bligh (2008), moving beyond a student-centered individual approach to one where the student-patient interaction becomes central and the physician educator serves as expert resource. This model focuses on knowledge production, as opposed to knowledge reproduction, emphasizing co-construction of knowledge in the environment of medical education. Whereas earlier curricular reform focused on broad areas of quality improvement in pre-clinical medical education, recent reform attention is focused more on knowledge improvement in practice elements, such as patient safety, the social context of medicine, team and organizational skills development, and issues of social justice in health care (Berwick & Finkelstein, 2010). Similarly, there are calls for increasing the integration of biomedical informatics technology in medical education into various aspects of medical training and practice (Berner & Boulware, 1996; Berwick & Finkelstein, 2010; Patel & Kaufman, 1998; Shortliffe, 1999); even to expanding teaching of the basic curriculum in e-learning environments (Ruiz, Mintzer, & Leipzig, 2006). Calls for evidence-based medical
practice (EBM) continue to coincide with the explosion of mechanical and bioinformatics capability in medicine and incorporating medical education efforts as in Best Evidence Medical Education (BEME) (Dauphinee & Wood-Dauphinee, 2004; Majumder, D’Souza, & Rahman, 2004). Aligned with calls to integrate research evidence into medical practice, are calls to educate students as critical thinkers, and increased attention to enhancing diversity in the composition of classes of medical students, faculty, and staff in medical schools (Smedley, et al., 2004). Overall, calls for curricular reform in 2010 include helping students to develop thinking and self-assessment skills, knowledge of health care systems and organizational management, understanding of the social aspects of health care, and integration of curricular elements throughout medical training (Irby, Cooke, & O’Brien, 2010).

As with any profession, medicine is learned in the context of a specialized body of knowledge where analytical, problem solving, and clinical procedures are learned in context as an application of discipline specific research and theory (Harris, 1993; McGuire, 1993; Schon, 1983). Professional education is a transformational initiation into the content, context and modes of thinking peculiar to the discipline (Donald, 2002); goals include transmitting knowledge, skills, and also the values of the profession (Cooke, Irby, Sullivan, & Ludmerer, 2006). A certain quality of discipline-related thinking is what distinguishes the expert level of functioning in a given field, and has been characterized as the ability for knowledge-in-action, reflection-in-action, and reflection-about-action (Harris, 1993; Schon, 1983). These are tacit or implicit levels of functioning that an expert attains after years of training and skill development. Knowledge-in-action is how experts address complex, unique, and conflicting practice problems by relying on discipline knowledge, but acting in the moment using their
experience to guide decisions (Harris, 1993). However, despite some consensus on what expert knowledge means, the exact nature and description of expert level performance in medicine is continuously debated (Mylopoulos & Regher, 2007). The nature and quality of teaching in medical education, as well as measures of professionalism in training and practice are similarly openly debated (Brennan & Coles, 2003; DasGupta, et al., 2006; Wilkinson & Harris, 2002). This culture of debate and renewal is characteristic of the medical education profession, creating opportunities and challenges that impact students as they move through the training regimen.

**Challenges and Opportunities for Students and Medical Educators**

What then, are the optimal learning and thinking characteristics for students currently entering medical school? First, high levels of motivation and ambition are typical of medical students, as well as oftentimes a personal connection to the practice of medicine. In some cases, students are empowered and specifically choose a medical school which uses a self-directed curriculum model, other students may be challenged by the unexpectedly high level of learning autonomy, and the attendant expectations for a prerequisite regulation of learning capability (Reaume & Ropp, 2005). That is, more personal responsibility and self direction for independent learning earlier in medical training, creating early pressure to learn enough and learn the right things, as well as the judgment to choose among conflicting information claims regarding basic content knowledge, along with self assessment skills that may not have been as salient earlier. Although some of these learning characteristics were always true of medical education, and other graduate level programs, the increasing amount and frequency of new information added to the medical curriculum combined with the speed in
which students are expected to master the information adds another level of complexity to medical education.

Second, the combination of complexity of learning environment, volume of material to learn, time pressures, and types of assessment often lead students into a situation of memorization without learning, rather than memorizing what has actually been learned (Regan-Smith, et al., 2003). Critics charge that novice medical students cannot possess the necessary foundation of knowledge and self awareness to accomplish this level of independent learning (Gruppen, White, Fitzgerald, Grum & Woolliscroft, 2000; Shanley, 2007), although supporters of the self-directed learning approach argue that students actually improve performance due to the autonomy and enthusiasm inherent in independent self-directed learning (Kaufman, 1985).

Third, developing expert levels of knowledge, skills, and abilities may not be an automatic process, and the emerging levels of expertise may depend on the particular student as well as the learning environment within which they train. Expert level practice is a complicated and flexible adaptive response which is dependent on the situation and the particular practitioner’s intellectual and practical experience (Mylopoulos & Regehr, 2007). Experts tend to remember new information in their field better, they implement a well developed knowledge base with well developed representations to solve problems, and they attain their expert level of cognitive functioning only after many years of practice (Gilhooly, 1990). Developing this expert level of knowledge manipulation can take much longer in certain information and context rich disciplines, such as medicine and medical diagnosis (Mustafa, Kemp, & Kemp, 2007). This could be a central challenge in medical education models today, that students are expected to emulate expert practices as a learning method (for
instance with the PBL, TBL, and CP models), even as they begin training as novices in content and applied knowledge areas that are new to them. Meanwhile building this foundational content knowledge is largely self-directed and therefore inconsistent (Shanley, 2007).

Fourth, the more confident, academically prepared and flexible students will succeed despite challenges due to particular curricular methodology. However, students who begin medical school to some degree already at risk for academic difficulty due to weak prior knowledge and study skills can be even more challenged by these particulars of medical curriculum format and methods. Additionally, personality characteristics have been observed to influence a student’s motivation, choice of learning strategies, communication style, and level of achievement (Knights & Kennedy, 2007). Reasons for academic difficulty in general however, are as diverse as the student body, and not always directly related to learning and studying problems (Sayer, DeSaintonge, Evans, & Wood, 2002). The personal exposure of group learning challenges all students to actively participate, articulate and explain aloud or demonstrate on a white board, the biological and chemical mechanisms and processes they are currently trying to understand. For quieter, more introverted, or naturally reticent students this learning environment can be difficult. Again, for students subject to stereotype threat in these educational situations, it can compromise performance (Schmades & Johns, 2003; Smedley, et al, 2004; Smith, 2004; Woolf, Cave, Greenhalgh, & Dacre, 2009).

Fifth, purposeful attention to helping students develop their reasoning ability has traditionally been a central part of medical education, as ability to think critically and correctly analyze clinical situations is central to medical practice (Cooke, et al., 2006; Scott, Markert, & Dunn, 1998). Critical thinking can be seen as integral to developing clinical
knowledge and clinical reasoning as they are dependent on the same core cognitive processes. Critical thinking informs and allows for the development of clinical judgment and knowledge (Facione & Facione, 1996), although measures of critical thinking are not good predictors of clinical performance (Scott, et al, 1998). Attempts to directly include critical thinking training in the medical curriculum is challenging, largely due to the complex nature of medical problem-solving and the complexity of the learning environment (Harasym, Tsai, & Hemmati, 2008). Even when critical thinking is explicitly included in curriculum components, students may not actually integrate and use this critical thinking in their developing medical modes of thinking. Beyond skills development, critical thinking includes developing professional judgment, as possessing skill in critical thinking does not automatically imply use of this skill (Facione, Facione, & Giancarlo, 2000; Facione, Giancarlo, Facione, & Gainen, 1995).

Sixth, mastery of discipline knowledge is a lengthy process as it is based on a specific body of concepts, research, and practical application (Donald, 2002). Methods to understand, manipulate, and consolidate information vary considerably between disciplines (for example, Literature, Chemistry, and Sociology), because the necessary thinking often varies —from deductive to interpretive” (Donald, 2002, p. 279). This is relevant to new medical students, who begin medical school with various pre-medical majors and the resultant discipline-dependent content knowledge, thinking, and learning process training. Premedical education differs in learning environment, which includes thinking patterns and discipline specific cognitive and behavioral processes. New medical students will additionally have various degrees of command of the medical pre-requisite science coursework, schema development, ability for domain specific critical thinking and problem
solving, and contextual learning regulation capability. Interestingly, there is evidence that
greater differences in achievement are noted between high and low prior achievers when
organizing and structuring of instructional support is provided by course faculty, and less so

Lastly, there are calls for new medical curriculum models and innovations to more
specifically and purposefully address the complexity in the medical education environment
(Bleakley, 2006; Harasym, et al, 2008). This is most true for the clinical training years, but
even in the first two years of training, educators are encouraged to use distributed knowing,
and learning in time and space (Bleakley, 2006) to inform their curriculum development.

Acknowledging the reality of unpredictability in medicine, especially clinical settings, is
important for students as they transition from basic science into clinical training. To help
students with this transition and save them and their patients frustration, the limits of
predictability in natural systems can be productively taught in terms of chaos theory,
indicating that predictions for health outcome are dependent on a variety of unknowns and
uncontrollable factors (Markham, 1998). This unpredictability aspect, however, can itself be
very challenging to some students who rely on instructors to guide them toward some level
of certainty in their training.

Learning Processes and Construct Contributions from Educational Psychology

Clearly students with a strong foundation in basic science plus learning flexibility and
fluency in self-regulation are most likely to succeed in medical school (Nietfeld & Schraw,
2002; Williams, Saizow, & Ryan, 1999). The successful medical student relies on skills in
self regulation, self assessment, critical thinking, metacognition, time management, efficacy
beliefs, goals for learning, and a repertoire of learning strategies that function well in the
environment of medical school, as well as the cognitive flexibility to change their learning methods, and seek additional resources when needed. Cognitive aspects of the learning process operate similarly for most students, although learning environment can enhance or challenge students' ability to learn effectively. Basic learning processes encompass affective, cognitive, and behavioral aspects. Affective operations describe the will, the expectancy component to learning, encompassing the student's beliefs and goals for the learning episode; cognitive operations describe the learning and knowing process, encompassing the student's metacognitive and monitoring skill; and behavioral operations describe what students actually do, encompassing the behaviors and actions that students implement to improve their learning. Learning is complex in any environment, as the quality of learning is dependent on many factors, such as intention and motive (Meyer, 1995). Next, more specific descriptions of the psychological constructs of learning self regulation, self efficacy, goals for learning, metacognitive monitoring, and approaches to learning follow.

**Learning self regulation.** Whether developed prior to or in medical school, success in this highly autonomous learning environment necessitates well developed learning self regulation skills. Students must be able to routinely set and move toward achieving personal goals for learning, identify and obtain the needed resources, and correctly assess their own learning processes, accomplished with the belief that they have the capability to achieve their learning goals (Zimmerman & Schunk, 2001); and these are a combination of cognitive and metacognitive skills (Wolters, 1998). Self regulation skills are domain and context specific and have been shown to explain some of the variance seen in academic performance (Evensen, Salisbury-Glennon, & Glenn, 2001). Strong prior knowledge and effective learning self regulation are said to be reciprocal (Nietfeld & Schraw, 2002), in that students
with effective self-regulation tend to perform better which translates into more knowledge moving into long-term memory, richer schema development, building toward a complex knowledge base that is available for building upon in subsequent learning situations. Self regulation skills, however, are not automatically developed and many college and graduate level students do not operate with an optimal level of self regulation in learning (Peverly, Brobst, Graham & Shaw, 2003). Development of self regulation skills has been associated with the type of goals held for learning, as intrinsic or mastery goals tend to support self regulation in learning tasks and extrinsic or performance goals tend to obstruct this development (Pintrich, 1999). This has also been shown with measurements of learning motivation in the medical school environment, in terms of autonomous or controlled motivation, with autonomous motivation being associated with higher levels of self regulation and achievement (Sobral, 2004).

The potential to access and transfer knowledge into new, applied or theoretical arenas can be seen as dependent on these cognitive regulation skills, originating with meaningful, deep learning processes (Lehman & Schraw, 2002; Mayer, 2002), and appropriate feedback to help students develop self regulation skill (Butler & Winne, 1995). Students need to develop their self assessment ability by clearly identifying areas of weakness and the resources available to assist them, and having a willingness to tap their repertoire of learning strategies to overcome their learning lapses (Everson & Tobias, 1998; Kaufman, 2003; Mayer, 1998; Nietfeld & Schraw, 2002; Schraw, 1998; Schraw & Nietfeld, 1998). The expanded and extensive demands placed on medical students in terms of volumes of new material and time pressure challenges even the most self regulated student, and can create barriers to learning for students already at risk of academic difficulty. Time management is a
crucial skill for successful medical education and clinical training and clinical practice (Covic, Adamson, Lincoln & Kench, 2003), even surpassing social supports (Rospedia, Halpert, & Richman, 1994).

In addition to cognitive and environmental control, students must be able to control and manage the various emotional, affective, and motivational aspects of learning, including beliefs about learning (Cate, Snell, Mann, & Vermunt, 2004; Järvelä, 1998; Kaufman, 2003; Sayer, DeSaintonge, Evans, & Wood, 2002). Medical students need to prepare for the salience of affective responses to their clinical experiences. Emotional responses to patient illness, surgery, and personal circumstances and the impact on patients and their families, are unmistakably authentic experiences which can both challenge and support a student's integration of clinical knowledge. Affective regulation issues include the need for strategies to regulate emotion related to test taking and other academic assessments (Kitsanas, 2002; Sarason, 1984; Schutz, Davis & Schwanenflugel, 2002). Students also need active strategies to help them rebuild their self esteem after academic setbacks and other barriers (Rospedia, et al, 1994; Segal, Giordani, Gillum, & Johnson, 1999; Slotnick, 2001). Students must be flexible with all aspects of motivation to remain consistent and successful in their academic work.

**Efficacy beliefs.** Feelings of personal agency are informed by students‘ belief in their potential to learn and be successful in a particular learning environment. This personal belief is also described as efficacy belief, as it is specifically a belief in one's own potential to succeed with a particular task, at a particular time, and in a particular environment. Social cognitive theory in particular explains a pivotal interaction between individuals thinking and learning processes and their current social environment (Alderman, 1999). The agency a
student feels in a particular environment is influenced by the beliefs they hold about their potential for success in that environment. Efficacy belief is also a central concept in Attribution theory as efficacy beliefs are seen to partly explain an individual’s attributions relative to their personal control over events that affect them (Gecas, 1989), and the explanations made to explain events. Albert Bandura describes four classic ways in which efficacy beliefs are acquired (1994):

- performance accomplishments—the way that accomplishments are given, received, and perceived (includes grades and social environmental factors such as racism, stereotype threat, prejudice, sexism)
- vicarious learning through observation of others (including availability of personally compatible role models)
- verbal or social persuasion—what others have to say about our potential performance
- physical-affective status, or emotional states, such as stress and anxiety which can negatively influence development of self-efficacy beliefs

Practically, a higher level of efficacy beliefs is associated with increased study time, effort and persistence; similarly, students with low efficacy beliefs are likely to hold back on both degree of effort and persistence in the learning task (Bandura, 1994; Greene & Miller, 1996; Schunk, 2001). High efficacy students are more likely to see their failures as due to changeable factors such as insufficient effort or lack of knowledge. In contrast, low efficacy learners tend to attribute their failures to basic tendencies such as lack of ability, which compromises their persistence with learning tasks (Bandura, 1994). Low efficacy students may experience performance anxiety to a greater degree than students with higher efficacy beliefs because of these attributions explaining success and failure (Greene & Miller, 1996).
Self-efficacy beliefs are a better predictor of persistence after failure, over self awareness which may exacerbate low efficacy beliefs with increased negative attention (Jacobs, Prentice-Dunn & Rogers, 1984). Self-efficacy beliefs also support a student’s self assessments of learning while impacting motivational aspects of learning, such as maintaining goals for learning (Bandura & Cervone, 1983). High self efficacy has been associated with deep approaches to learning in medical students (Papinczak, Young, Groves, & Haynes, 2006), as well as above average performance (Mavis, 2001).

Efficacy beliefs also impact the learning environment, because beliefs about potential performance have strong influence on behavior related to that performance (Pajares, 1996). Persisting in the face of learning difficulty involves a combination of personal standards for performance along with knowledge of actual performance (Bandura & Cervone, 1983). When high self efficacy students are dissatisfied with a low performance, they are sufficiently motivated by their high performance standards and expectations of success to employ the necessary additional effort to improve their performance (Bandura & Cervone, 1983; Zimmerman, Bandura & Martinez-Pons, 1992).

**Achievement goals.** A student’s goals for learning can be understood as the embodiment of his or her efficacy beliefs toward a learning task. Achievement goals express the students’ understanding of their learning capability in a given context, and intention for learning which includes their motive for learning (Meyer, 1995) and expectations of success. Achievement goals are “cognitive representations” of what a student wishes to accomplish (Harackiewicz, Barron & Elliot, 1998). Without positive efficacy beliefs a student will struggle to envision success with a learning task, and is therefore likely to fail in establishing long term and short term goals for attaining that success (McGregor & Elliot, 2002). With
clear, personal goals for learning a student can develop the necessary expertise in the use of strategies, self instruction, self monitoring, and environmental controls which allow for learning success. Therefore, a student’s various goals for learning emerge from the specific learning task combined with their intent and expectation for learning outcome (Elliot, McGregor, & Gable, 1999; Sobral, 2004).

Theorists describe qualitatively different learning or achievement goals as mastery or performance oriented (Elliot, 1999). Mastery goals are characterized as intrinsic and are based on a personal desire to learn for the mastery of the information. Performance goals, in contrast, are based on a student’s intent to fulfill expectations for performance or to obtain a favorable grade and ranking relative to peers, and are described as extrinsic due to this external focus (Elliot, 1999; Harackiewicz, et al, 1998; Rawsthorne & Elliot, 1999). Mastery or intrinsic goals have been associated with facilitation of developing learning self regulation (Pintrich, 1999). Although representing different orientations to a learning situation, mastery and performance goals are not in themselves either positive or negative, nor are they mutually exclusive, but operate in relation to the learner’s level of perceived ability and perceived competence. Accordingly, both mastery and performance goals can potentially enhance intrinsic interest (Harackiewicz, et al, 1998).

Achievement Goal Theory describes achievement goals operationally through the mechanism of a competence construct, meaning that the learner determines their own personal standard of performance. These standards can be absolute (based on the requirements of the task itself), intrapersonal (based on one’s own past attainment or maximum potential attainment), or normative (based on the performance of others) (Elliot, 1999; Elliot & McGregor, 2001, p. 501). Similarly, a practical orientation to learning is
described with the two dimensions of definition (the way an individual defines competence) and valence (the value given to the judgment of competence) (Elliot & McGregor, 2001, p. 502). Valence is the degree of attractiveness attached to a learning activity (Williams, et al, 1999), it is an affective element which explains why students orient in the way that they do toward a learning task (Elliot, 1999). The valence dimension is composed of the learning regulation aspects of approach and avoidance (Elliot, 1999; Elliot, McGregor & Gable, 1999). Approach implies expectations of learning success and competence, and avoidance implies fear of failure, and avoidance of judgments of competence (Elliot & Church, 1997). The valence dimensions of approach and avoidance can also be observed in personality temperament in the way behavior goals emerge in a social-cognitive context (Elliot & Thrash, 2002), and in certain personality traits which have been positively associated with intrinsic motivation in medical students (Tanaka, Mizuno, Fukunda, Tajima & Watanabe, 2009).

Achievement Goal Theory has posited that achievement goals are specific to a learning situation, arise from a personal orientation to competence (mastery or performance), and an associated valence toward the achievement (approach or avoidance). Therefore, the achievement goals model has most recently been shown as a 2x2 framework, encompassing the dimensions of mastery-approach, mastery-avoidance, performance-approach, and performance-avoidance (Elliot & McGregor, 2001). Mastery goals can manifest in both the approach and avoidance dimensions. Mastery-approach goals indicate all the elements of a positive orientation to learning; mastery-avoidance goals indicate some negative qualities in that although the student holds mastery intent for learning, their goal is somewhat compromised by fear of failure (Elliot & McGregor, 2001). Performance-approach goals are
considered positive because they imply interest in improving performance (Elliot, et al., 1999). Performance-avoidance goals have a negative connotation due to the presence of affective fear elements such as test anxiety (Elliot & McGregor, 1999; McGregor & Elliot, 2002), and the focus on avoidance of incompetence relative to others (Elliot, et al., 1999). Achievement goals tend to remain consistent within a learning situation, except where fear of failure forces such a change (Fryer & Elliot, 2007). Mastery goals are related to hope and pride and are positive predictors of increased levels of enjoyment in learning, whereas performance-avoidance goals are related to anxiety and suggestions of shame and hopelessness (Pekrun, Elliot, & Maier, 2006, p. 589). Finally, a multiple goals perspective has been tested where mastery goals predict continued interest in a subject, but not grades, and performance goals predict grades, but not necessarily interest (Harackiewicz, Barron, Tauer, Carter, & Elliot, 2000).

**Metacognitive monitoring.** Acknowledging the importance of beliefs and goals for learning, students must also be able to evaluate their learning quality while it is occurring. This is especially true of complex learning environments where students have a substantial role in identifying learning tasks and organizing, assessing and using resource materials. If a student assesses their learning as successful and substantial, this tends to promote motivation for learning and continued effort toward meeting learning goals. Similarly, a self assessment that learning is inadequate can motivate students to improve their learning and study strategies (Schunk, 2001; Thiede, Anderson, & Therriault, 2003); the main issue is that the self assessment be meaningful. This is a difficult and non automatic process, as even when areas of weakness are acknowledged a student may not change their cognitive strategies as required to improve learning (Regehr & Eva, 2006), or in other ways may not generally use
the metacognitive knowledge of learning to improve self-regulation (Schraw, 1994). Instructors are in a good position to encourage self-assessment with reflection and explicit guidance on learning process in their discipline. Reflection while learning is a vital component of monitoring learning, as well as informing the need to alter learning strategies when necessary. Reflection while learning is a metacognitive skill, as an awareness of cognitive function (Dunlosky & Metcalfe, 2009; Sobral, 2005), and has been associated with meaningfulness of course material as well as perceived competence and course achievement (Sobral, 2000). Interestingly, reflective writing has been successfully implemented to help students bridge the basic science, clinical science, and personal affective aspects of medical training, and in some instances this process is openly mentored and validated (Reichert, Solan, Timm, & Kalishman, 2008).

The ability to reflect on one’s learning process is a metacognitive skill, and the tool which allows the learner to assess and monitor their learning as it happens. In fact, awareness, understanding, and management of thinking processes is dependent on metacognitive skill (Tobias, Everson, & Laitusis, 1999; Young & Fry, 2008); and metacognitive processes can only be used when the cognitive processes are conscious, or known to the learner (Rosenthal, 2000). Metacognitive monitoring is how a student assesses quality, appropriateness, and depth in their learning task, an awareness which allows for regulation of learning process behavior. Metacognition is described with two dimensions, knowledge of cognition and regulation of cognition (Everson & Tobias, 1998; Schraw, 1998; Schraw & Dennison, 1994). Metacognition is the cognitive tool used to accurately make that assessment of quality of new learning, and allow the student to use this information to manage learning by separating what is already known from what is not yet learned. Schraw
(1998) describes knowledge of cognition as of three types: *declarative* (knowing about things), *procedural* (knowing how to do things), and *conditional* (knowing why and when to use declarative and procedural knowledge). Declarative knowledge includes knowing oneself as a learner, understanding the factors influencing learning. Advanced procedural knowledge leads to skill automaticity developed from an ability to "chunk and categorize" learning materials. Conditional knowing helps the student develop ways to successfully manage their learning (Schraw, 1998; Young & Fry, 2008).

Once a student demonstrates awareness of the learning processes, the potential for regulation of those processes begins (Lan, 1996; Pressley & Ghatala, 1990; Thiede, et al, 2003). Metacognitive regulation of cognition allows for improved learning due to better attention, discrimination in learning, use of strategies, and awareness of learning quality (Schraw, 1998). It is likely, however, that monitoring accuracy allows for improved self-regulation, which in turn impacts level of performance, rather than monitoring accuracy directly impacting performance (Thiede, et al, 2003).

The cognitive skill of monitoring one’s level of learning while it occurs is challenging for students, especially when the content area is new. Self assessment in terms of judging one’s quality of learning can be clouded by the many affective and cognitive issues as described above, in addition to operating at the novice level of discipline knowledge. Learners make judgments about their learning quality which inform their ongoing learning behaviors, such as continuing with the same learning strategies, changing to something new, or asking for assistance. These strategy judgments have been characterized as "―confidence judgments‖ about learning quality, and have been used as a measure of metacognitive monitoring (Isaacson & Fujita, 2006; Schraw, 2009, p. 34), and to teach students monitoring
skills (O'Keefe, Wildemuth, & Friedman, 1999; Sobral, 2000). The mechanism is that at any
given point in a learning process, students can report a certain confidence level regarding
their comprehension and expected performance. This cognitive process has been
characterized as moving from —Ease-of-Learning Judgments, to Judgments of Learning,
Feeling-of-Knowing Judgments, Source-Monitoring Judgments, and Confidence in Retrieved
Answers” (Dunlosky & Metcalfe, 2009, p. 40-41). Confidence judgments have also been
considered as Judgments of Learning (JOL), meaning a student’s ability to judge their
learning quality and completion during the learning process. JOL are best measured after a
short duration, so that the new information is cleared from short term memory, necessitating
that the student retrieve the information from long term memory (Nelson & Dunlosky, 1991).
For example, improvements in learning accuracy were shown with reading text and
generating keywords after a short delay (Thiede, et al, 2003). Both children and adults miss
inaccuracies in text, although there appears to be a developmental difference or improvement
over time, especially with testing (Pressley & Ghatala, 1990). Comprehension and
metacomprehension are different processes, since understanding a text for instance, and
knowing to what extent the text has been understood are different self evaluative processes
(Griffin, Wiley, & Thiede, 2008). This explains some of the difficulty in measuring
metacognitive monitoring activity. Despite the fact that metacognition in general, and
monitoring ability in particular, is widely held as vital to learning regulation, identifying
techniques to accurately measure these processes has been difficult. Despite the difficulties in
distinguishing levels of understanding, metacognitive monitoring has been measured using
the JOL, keyword, memory task, and self reporting techniques.
Education researchers have addressed the building of metacognitive capacity directly (Everson & Tobias, 1998; Mayer, 1998; Nietfeld & Schraw, 2002; Schraw 1998; Schraw & Nietfeld 1998), with the intention of building regulation of cognition skills. These regulation skills, facilitated by metacognition, are improved planning, monitoring, and evaluation (Schraw, 1998; Zusho & Pintrich, 2003). Planning is a skill which develops naturally over time and includes the ability to choose learning strategies that will work best in each situation. Monitoring is the awareness of comprehension, the awareness of how one is progressing in the learning task. This skill is poorly developed naturally, but can be improved with training and practice. Evaluation is the quality control mechanism students use to monitor their learning (Schraw, 1998).

**Approaches to learning.** Learning behaviors are the specific actions a student engages in as a result of efficacy beliefs, goals, and regulation skills. Approaches to learning are the specific behaviors encompassing the cognitive strategies and management behaviors necessary for learning to occur, are associated with the learning environment and instructional methods, and are adaptable to the learning situation. Students use their metacognitive skills to adjust their approaches to learning for individual courses, and according to particular assignments and tests within a given course (Reid, Duvall & Evans, 2005; Ross, Green, Salisbury-Glennon, & Tollefson, 2006).

Approaches to learning are traditionally characterized as deep, surface, and strategic. A surface approach is characterized by an extrinsic motive based on an expectation of positive or negative feedback, a deep approach is characterized by an intrinsic motive due more to curiosity or a commitment to understanding, and a strategic approach which is similar to the surface approach due to the reinforcement or focus on graded outcome
A student’s approaches to learning, as well as specific strategies for learning content, are contextual and domain specific. Approaches to learning additionally encompass learning behaviors such as monitoring and organizing study, and effort management (Mattick, et al, 2004). Distinctions in learning approach revolve around how a student processes new material. A surface approach keeps the to-be-learned material in its original format and learning is a process of reproducing information as presented. In contrast, a deep approach involves a reorganization of the material, which allows the learner a wider perspective on the information as well as the ability to relate the new material to prior knowledge (Thomas & Bain, 1982). The deep and surface demarcation need not be considered as absolute, however, since a strategic approach may actually combine elements of both approaches, as when students employ a memorization strategy but with the intention to understand the material (Kember, 1996; Marambe, Athuraliya, Vermunt, & Boshuizen, 2007). The strategic approach may also describe preferred learning behaviors in certain complex learning environments, such as medical school (Reaume & Ropp, 2005). Variations in approaches to learning have also been aligned with cultural differences, although the broad distinctions between seeking meaning and reproducing information remain (Richardson, 1994). The crucial point is the student’s intention for learning, which relates to the earlier discussion concerning a student’s goals for learning.

There is evidence that consistency in approaches to learning is contextual and dependent on the learning environment (Ross, et al, 2006; Stringer, 2002; Trigwell, Prosser, & Waterhouse, 1999), and even related to the sequential place in the course, beginning, middle, or end (Zusho & Pintrich, 2003). Learning environment includes specific teaching
approaches, meaning that if instructors present new material in ways that facilitate deep learning approaches, students are inclined to adopt these deeper learning approaches in their study (Marambe, et al, 2007; Shen, Hiltz, & Bieber, 2008; Trigwell, et al, 1999); relevant aspects to learning environment also include school characteristics and specific departmental factors (Abraham, Vinod, Kamath, Asha, & Ramnarayan, 2008). Students who adapt their learning approaches to the requirements of particular courses and testing modalities have a greater chance of academic success due to this learning flexibility, as performance has been shown to be mediated by the study strategies employed (Ross, et al., 2006). This practice of flexibility in learning approach is not automatic, however, and some students have difficulty adapting to new learning environments (Reaume & Ropp, 2005; Sayer, DeSaintonge, Evans & Wood, 2002). According to Dembo and Seli (2004), students resist changing learning strategies for a number of reasons, at least in college academic support programs, mainly because of a “belief that they can’t change, they don’t want to change, they don’t know what to change, or they don’t know how to change” (Dembo & Seli, p. 2). One challenge for novice medical students is refraining from over generalizing formerly useful learning strategies while addressing new content in the new learning environment. It could also be that differences in learning environment alone may not be a strong motivator for students to change formerly successful learning approaches (Reid, et al, 2005). In fact, a high stakes learning environment may have an opposite effect on student learning behavior, where pressure to excel creates an affective inability to significantly and adequately change learning strategies. Student perceptions of the learning environment are important indicators of student performance (Mayya & Roff, 2004). Students need to understand the cognitive context of each course, the unique way the material is presented, work out ways to study this
particular content, engage the specific metacognitive skills relative to this context, and then have adequate efficacy and flexibility to alter their learning strategies and pacing to suit the current learning environment. Therefore, learning strategies must be contextual, and situated within the domain content, actively involve the learner by encouraging and building metacognitive awareness, and focused in the specific learning environment (Hattie, Biggs, & Purdie, 1996).

The assumption in medical education, as well as much of higher education, is that the deep approach to learning is the gold standard (Reid, et al, 2005), and that surface or strategic approaches imply ineffective or temporary learning outcomes. However, it could be that strategic or surface approaches to learning are common in undergraduate education (Tomanek & Montplaisir, 2004). There is evidence as well that medical education, at least traditionally, promoted a more surface learning approach (Reid, et al, 2005), a situation which recent curricular changes have been attempting to address.

**Learning Process and Interventions in Medical Education**

Attempts to build academic skills for new medical students through early intervention programs have been reported (Saks & Karl, 2004; Segal, et al, 1999). The earliest point of academic support, coordinated directly by medical schools for medical and pre-medical students, is commonly the post-baccalaureate or pre-matriculation programs. Common features include training in study and test taking skills, additional course work, and academic and pre-professional counseling (Blakely & Broussard, 2003; Carline, et al., 1998; Giordani, et al., 2001; Strayhorn, 2000). Programs differ on implementation details and focus, often related to funding source as well as student interest. For example, some program offer opportunities to work in a science lab, to develop personal and leadership skills, or
counseling to help with emotional and academic stress (Giordani, et al., 2001). There are also intensive summer programs which concentrate on course work and test taking skills development (Blakely & Broussard, 2003). Generally students who participate in post-baccalaureate programs enter medical school and successfully complete medical training on a par with other medical students in their class (Blakely & Broussard, 2003; Giordani, et al., 2001; Strayhorn, 2000). Unfortunately, post baccalaureate programs have not been conducive to control group or comparison group studies, making it difficult to isolate the effects of individual program components to determine which are most likely to contribute directly to academic success in medical education (Carline, et al., 1998).

Pre-medical educators have reported programs designed to address academic skill building, which also have relevance for medical education. For example, using the cognitive-apprenticeship model to create a specific scaffolding learning environment with pre-college students (Järvelä, 1998), and using the personalized system of instruction (PSI) model of mastery learning in undergraduate biochemistry (Occor & Osgood, 2003; Reese, 1998). Some medical schools have tried formal intervention programs early in the curriculum with varied success (DeVoe, et al., 2007; Segal, et al., 1999), as this targeted early scrutiny can also exacerbate an at risk student’s already low efficacy for medical education (DeVoe, et al., 2007). Some schools provide an avenue for students experiencing academic difficulty through deceleration, or decompression of the curriculum, in that students are able to reduce their course load and continue moving forward in the curriculum (Kies & Freund, 2005), although many medical curriculum formats do not easily accommodate this flexibility.

Following is a sample of successful interventions which have been reported by medical educators. These examples include efforts:
• to build learning environments for medical students which specifically promote self regulation and self determination, with the learning-oriented teaching (LOT) model (ten Cate, Snell, Mann, & Vermunt, 2004);

• to help students develop personal reflection skills through authentic experiential learning using portfolio assessment (Aukes, Geertsma, Cohn-Schotanus, Zwierstra, & Slaets, 2008);

• to integrate concept mapping as a strategy to encourage deep learning, where the instructor creates a map to guide students' learning in showing organization and integration of important concepts, as a pre-lecture organizer with students making their own maps post-lecture (Fonseca, Extremina, & Fonseca (2004);

• to introduce a Mindfulness-Based Stress Reduction (MBSR) course to improve medical students coping skills and reduce emotional stress (Rosenzweig, Reibel, Greeson, Brainard, & Hojat, 2003).

Curricular innovations are often particular to the curricular model of a given school, are developed based on shortcomings of the particular learning environment, technical innovation, or specific student population. For instance, the widely used PBL model has fostered interventions to help students in adapting to the small group learning environment, while also bringing awareness to the importance of integration of basic and clinical science (Blatt, Kallenberg, & Walker, 2000); enhanced self and peer assessment training in a PBL context to improve students' reflections on learning (Papinczak, Young, Grove, & Haynes, 2008); and an assessment of students' time planning and self-monitoring in a psychology course using the PBL model, where these skills were positively correlated with achievement (Van Den Hurk, 2006). One intervention described attempts to improve problem solving
ability in medical students using visual representation as a strategy to help students improve their diagnostic reasoning skills (Van Puymbroeck, et al., 2003). Another version of visual learning enhancement is group viewing of paintings for building awareness and team collaboration among medical students and residents (Reilly, Ring, & Duke, 2005).

Learning and studying skills building has been addressed with specific interventions, such as coordinating an elective course with small self-help groups to promote student’s self-directed learning skills (Sobral, 1997); and integrating a specific learning and study skills course into one six-year medical program during the first and third organ-system courses during the first year (Durak, Torun, Sayiner, & Kandiloglu, 2006). Concept sorting has been introduced as a way to assess students’ knowledge organization and schema development (McLaughlin & Mandin, 2002). Computer assisted learning has been gaining momentum in medical education, for example, Abdelhamid’s (1999) description of the Multidimensional Learning Model, which is a way to help students master the large medical curriculum more efficiently and effectively. This model is based on developing memory strategies which are based on three basic principles: the generation effect (students learn better when they generate the item); the spreading activation model (stored knowledge is understood as a network of interconnected data, so that when one piece of data is activated, this in turn activates other areas of the network); and the use of pictures (memorizing images is easier than memorizing verbal passages) (Abdelhamid, p. 1-2). Another example of computer assisted learning is using animated pedagogical agents as a way to engage and motivate student learning. One model described such a learning agent, Adele, who guides and assesses students as they work through clinical cases (Shaw, Ganeshan, Johnson, & Millar, 2000). Computer assisted learning demonstrates the wide range for curricular innovations in medical
education, many of which incorporate research findings from cognitive and educational psychology. The computer based tutor guide is one method of tutoring students, another is peer teaching, which tutored students value for the help from students who recently completed the same coursework and tutor-students value for the teaching experience (Lockspeiser, O’Sullivan, Teherani, & Muller, 2008). Another type of guided instruction is peer learning, as demonstrated with a role-play exercise in communication skills (Glynn, MacFarlane, Kelly, Cantillon, & Murphy, 2006), or cooperative learning in a first year pathology course (Kanthan & Mills, 2007). Cognitive apprenticeship models have been described in medical education but are more experimental than widespread (Bleakley, 2002; Durak, Certug, Caliskan & Van Dalen, 2006; Marckmann, 2001), and have also been reported in nursing education (Taylor & Care, 1999).

There is a notable increase in medical education research, as inconsistencies have been reported across medical education disciplines and departments contributing to inconsistencies in student training (Armstrong, Mackey, & Spear, 2004). Some have argued that repeated curricular innovations have had little positive effect on medical students’ learning experience and quality of outcome (Bloom, 1988). The costs and social benefits congruent with the training of physicians supports this growing research capability into the mechanics and performance of medical education programs nationally, in and outside academic health centers (Norman, 2008; O’Neil, 1998; Regehr, 2004; Shea, Arnold, & Mann, 2004). Medical researchers have most often concentrated in the areas of curriculum and teaching, student characteristics, professional skills and attitudes, and evaluation (Regehr, 2004). The profession’s self analysis is apparent with calls for increasing a research concentration in clinical outcomes (Chen, Bauchner, & Bustin, 2004), and calls to
incorporate a sociological perspective in the pre-clinical years of medical education as context which echoes the practice of medical diagnosis in the clinical practice years (Mathieu, 2004).

These interventions describe attempts by medical educators to integrate and apply knowledge gained through decades of education and psychology research to problems in medical education. Although many interventions use similar behavioral, cognitive, and affective constructs, attempts to specifically study the interaction of individual constructs is less often reported. Therefore, research focused on learning processes in medical school which investigates the interaction of specific constructs may prove useful.

Curricular changes in medical education have often been conscious attempts to encourage active learning specifically to create the environment for deep cognitive processing of information. Educational and cognitive science research describe the mechanisms involved with acquiring knowledge, the processing of this information in short term memory, and the storage of this knowledge in progressively more intricate networks in long term memory. The more expert the learner becomes, the more complex are the stores of knowledge and interactive networks (schemas) from which knowledge is drawn. Learning strategies generally considered conducive to deep learning, are those which facilitate this network development in long term memory. As described earlier, this schema development is crucial for developing expert level cognitive processing and performance.

Questions remain. Does the environment of medical education facilitate deep, surface, or strategic approaches to learning? Does the intent behind the various curricular changes become diffused through medical school and academic medicine environmental influences? One way to approach these questions is with analysis of learning environment in
an educational, health, political, and social systems perspective. Another way is to focus on student characteristics and analyze the relationships among elements of the learning process to understand the kinds of motivation students hold, how they use their learning goals to monitor and adjust their learning strategies to be successful in the particular learning environment of medical school.
Statement of Problem and Research Questions

Through both educational psychology and medical education research, many of the cognitive, affective, and behavioral factors necessary for medical students to succeed have been identified. Curricular changes over the last 60 years of medical education, research in cognition and learning, the dynamics of an increasingly diverse medical student body matching an increasingly diverse general population demographic, have all contributed to an awareness of the need to address student academic preparedness for the specific demands of a changing medical education landscape. As described, challenges for medical students include 1) an emphasis on autonomous learning modalities with the related self assessment and behavior management skills; 2) the great volume and speed of the curriculum; 3) an expectation that students will emulate expert practices as a learning method even as they begin training as novices; and 4) specific challenges for students at risk for academic problems due to weak pre-medical preparation along with the early need to systematize learning by organizing and personalizing goals and strategies. What remains unknown is the manner in which particular learning elements or constructs can be shown to support learning processes in the medical school environment.

Persistence with learning tasks in order to meet learning expectations and goals is one of the hallmarks of accurate and appropriate self regulation of learning, especially with complex learning tasks. Educational research has shown the necessity of both domain-specific self efficacy and the intent for learning as demonstrated by the particular goals for succeeding at the task, but also accuracy and skill in metacognitive monitoring that includes self assessment that reflects actual learning. Finally, students need to be able to rely on this
monitoring accuracy to choose and adjust their learning behaviors in the form of learning approaches and strategies to ensure their academic success.

Goals for learning and metacognitive monitoring ability have both been demonstrated as critical factors in the learning process. To understand the impact of these constructs in a particular learning environment, it is necessary to measure their relationship to a third construct, that is to what the importance or impact relates. Including a behavioral construct, approaches to learning, makes it possible to determine to what extent these two constructs influence behavior. Although educational psychology research has described and measured these constructs, they have not often been measured with premedical and medical students, nor have they been reported as being investigated together. Should one or the other of these constructs, achievement goals for learning and metacognitive monitoring, prove to be more predictive of a student’s engagement in elements of a behavioral construct, approaches to learning, the outcome information could be used to help students to enhance their cognitive processing and self regulatory skills in a medical school context.

The behavioral construct, approaches to learning, was chosen as the dependent variable for this study because of a clear connection to deep cognitive processing, a construct which is not easily measured. The construct, achievement goals for learning, will be used to address a student’s intent and motivation for learning in the context of medical school. The construct, metacognitive monitoring (awareness and control of cognition), will be used to measure a student’s skill at learning regulation, including planning, monitoring, and evaluating of their learning.

The purpose of this study is to discover the relationships among factors of the achievement goals construct, the metacognitive monitoring construct, and the approaches to
learning construct, in three classes of medical students, and to discover if there is a difference among first, second, and third year students. Based on the explanations, considerations, and questions raised in the discussion above, the following research questions will be explored.

RQ #1 How do the achievement goals subscales relate to the approaches to learning subscales?

RQ #2 How do the metacognitive monitoring subscales relate to the approaches to learning subscales?

RQ #3 How do the achievement goals subscales relate to the metacognitive monitoring subscales?

RQ #4 Do the demographic variables of gender, ethnicity, undergraduate major, graduate major, year degrees earned, age and undergraduate GPA have a relationship with the variables comprising the achievement goals, metacognitive monitoring, and approaches to learning constructs?

RQ #5 Are there mean differences among approaches to learning for first, second, and third year students?

RQ #6 Is the relationship between the variables MCAT score and medical school GPA moderated by any of the five approaches to learning?

RQ #7 Are any of the achievement goals or metacognitive monitoring subscales more predictive of the deep approach and surface approach subscales of the approaches to learning construct?

RQ #8 Can one of the achievement goals or approaches to learning subscales be shown to independently predict the medical school Phase 1 GPA?
Methods and Description of Data

To examine the relationship between medical students’ achievement goals and approaches to learning, this study used a self report questionnaire completed by three different classes of medical students. Generally, mastery achievement goals are known to correlate with deep learning strategies, and performance achievement goals are known to correlate with surface learning strategies. This study examined students reported goals and strategies to determine if these and similar relationships hold true of medical students. Additional relationships were explored based on analyses of gender, age at matriculation, ethnicity, undergraduate major and GPA, MCAT score, Phase 1 GPA, and year in medical school with the study’s subscales.

Recruiting of Participants

Using this convenience sample, first year medical students were recruited during their third block/course of their first year, (Phase I-I), Infectious Disease & Immunity (November 30, 2009-January 15, 2010). Data were collected December 14-23, 2009, with follow up emails requesting participation. Second year medical students were recruited during the final block/course of their second year (Phase I-II), HS&R/Endocrinology (November 9-December 17, 2009). Data were collected December 14-23, 2009. Third year medical students were recruited during their second Phase II clinical performance exam, Objective Structured Clinical Exam (OSCE), December 11, 12, and 15, 2009. Students were recruited in person by the researcher during the mandatory exam orientation, twice each day over the three exam days.

In the medical curriculum experienced by study participants, basic science predominates in the first 15 months, known as Phase I (first year students in this study were
in their 5th month, 3rd course of medical school), and (second year students in this study were in their 15th month, final basic science course of medical school-still Phase 1). After completion of the United States Medical Licensing Exam (USMLE), Step 1, a month following for research, required clinical clerkships cover the next 12 months, this is known as Phase II (third year students in this study were in their 9th month of Phase II, just past the middle of their required clerkships). Phase III students are in their 4th year of medical school and were not surveyed in this study.

Data Sources

Instruments. Existing participant demographic and performance information was requested from the medical school’s Program Evaluation, Education & Research (PEAR) office, with approval granted by the Associate Dean for Undergraduate Medical Education (UME), and the Director of the PEAR office. Demographic information requested included: gender, age at matriculation, ethnicity, undergraduate major, graduate degree; and performance data requested included: Medical College Admission Test (MCAT) combined score, undergraduate GPA, and medical school (Phase I) GPA. The Medical Student Learning Questionnaire asked students for their student identification number (Banner ID number), year in medical school, and date. Student ID numbers and scores from the questionnaire were merged with demographic and performance data, matched for each participant by their personal identification code number. A third party (PEAR office) created the research database from this merged data by establishing a new coding system in a randomly scrambled list (eg, participant 1, 2, 3, etc). Scores from each participant’s questionnaire, along with demographic information were first entered into an Excel
spreadsheet by the researcher for analysis, and then transferred into a SPSS dataset. Descriptive statistics for the sample are shown in Table 1.

Table 1

Sample Descriptive Statistics.

<table>
<thead>
<tr>
<th></th>
<th>First Year</th>
<th>Second Year</th>
<th>Third Year</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>63</td>
<td>59</td>
<td>82</td>
<td>204</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>36 (57%)</td>
<td>34 (58%)</td>
<td>44 (54%)</td>
<td>114 (56%)</td>
</tr>
<tr>
<td>M</td>
<td>25 (40%)</td>
<td>25 (42%)</td>
<td>38 (46%)</td>
<td>88 (44%)</td>
</tr>
<tr>
<td>Missing Data</td>
<td>2 (3%)</td>
<td></td>
<td></td>
<td>02 (.010%)*</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anglo</td>
<td>27</td>
<td>26</td>
<td>41</td>
<td>94</td>
</tr>
<tr>
<td>Hispanic</td>
<td>15</td>
<td>21</td>
<td>24</td>
<td>60</td>
</tr>
<tr>
<td>Native American</td>
<td>8</td>
<td>3</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>African American</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Asian</td>
<td>4</td>
<td>3</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Unidentified</td>
<td>8</td>
<td>5</td>
<td>7</td>
<td>20</td>
</tr>
<tr>
<td>Age at matriculation</td>
<td>202</td>
<td>25.03</td>
<td>25.27</td>
<td>24.74</td>
</tr>
<tr>
<td></td>
<td>(3.39)</td>
<td>(4.00)</td>
<td>(2.55)</td>
<td>(3.31)</td>
</tr>
<tr>
<td>MCAT</td>
<td>200*</td>
<td>28.5</td>
<td>27.98</td>
<td>28.12</td>
</tr>
<tr>
<td></td>
<td>(4.00)</td>
<td>(4.50)</td>
<td>(3.55)</td>
<td>(3.96)</td>
</tr>
<tr>
<td>Undergraduate GPA</td>
<td>200*</td>
<td>3.57</td>
<td>3.63</td>
<td>3.60</td>
</tr>
<tr>
<td></td>
<td>(.283)</td>
<td>(.284)</td>
<td>(.286)</td>
<td>(.284)</td>
</tr>
<tr>
<td>Undergraduate Major</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>35% of sample -- Biology</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13% of sample -- Biochemistry</td>
</tr>
<tr>
<td>Graduate Degree</td>
<td>4 MA/MS</td>
<td>5 MA/MS</td>
<td>6 MA/MS</td>
<td>Masters 15 (7%)</td>
</tr>
<tr>
<td></td>
<td>4 PhD</td>
<td>2 PhD</td>
<td>2 PhD</td>
<td>PhD 6 (3%)</td>
</tr>
<tr>
<td>Phase 1 GPA</td>
<td>N/A</td>
<td>3.14</td>
<td>3.02</td>
<td>3.08 (average of two classes,)</td>
</tr>
</tbody>
</table>

Note: Totals do not equal 100% due to rounding. *Information unavailable for two transfer students.

The American Association of Medical Schools (AAMC) publishes student data for all U.S. medical schools (AAMC.org: Data Warehouse: STUDENT file, as of 10/26/2010). This study sample includes one of the higher representations of Native American medical students in U.S. medical schools (14 respondents out of a total school population of 20),
which is 2.1% of the national population of 654 in 2010 (the only states with higher school numbers are Minnesota [25], North Dakota [25], and Oklahoma [51]). The sample includes 60 Hispanic students (out of a total school population of 112), which represents .9% of the national population of 6,508 Hispanic medical students in 2010. The sample includes three African American students out of a school population of five, a very small proportion of the 5, 548 African American medical students nationally; 94 white students, out of a school population of 187, also representing a small proportion of the 47,525 white medical students nationally; and 13 Asian students out of a school population of 24, which also represents a fraction of the 17, 375 national population of Asian medical students. The total sample is approximately 74% of the first, second, and third year classes at the target medical school. Therefore, three quarters of the recruited students did choose to participate.

Additionally, students were asked on the study’s Questionnaire about when they decided to attend medical school. The majority of students in this sample indicated that they made their decision to apply to medical school while in college, with graduate school, post graduate and high school represented next. Table 2 shows the distribution for the decision to attend medical school for students answering this question.

Table 2
Year in School when Student Decided to Attend Medical School.

<table>
<thead>
<tr>
<th>Medical School Year</th>
<th>Younger than High School</th>
<th>High School</th>
<th>College</th>
<th>Post-Grad</th>
<th>Number of students responding</th>
</tr>
</thead>
<tbody>
<tr>
<td>First year students</td>
<td>6 (3%)</td>
<td>9 (5%)</td>
<td>30 (16%)</td>
<td>14 (7%)</td>
<td>59</td>
</tr>
<tr>
<td>Second year students</td>
<td>6 (3%)</td>
<td>5 (3%)</td>
<td>31 (16%)</td>
<td>12 (6%)</td>
<td>54</td>
</tr>
<tr>
<td>Third year students</td>
<td>11 (6%)</td>
<td>16 (8%)</td>
<td>43 (23%)</td>
<td>7 (4%)</td>
<td>77</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>190</td>
</tr>
</tbody>
</table>

Note: Percent based on total number of responses to the question.
Measures. The *Medical Student Learning Questionnaire* (see Appendix A) was constructed using three distinct published inventories described in detail below: 1) the Achievement Goal Questionnaire (AGQ); 2) the Metacognitive Awareness Inventory (MAI); and 3) the Approaches to Learning and Studying Inventory (ALSI).

**Achievement Goal Questionnaire (AGQ).** The 12-item Achievement Goal Questionnaire (AGQ) (Elliot & McGregor, 2001) was used to measure the construct *achievement goals for learning*. The inventory is comprised of four component subscales: mastery-approach, mastery-avoidance, performance-approach, and performance-avoidance, which were detailed in the previous chapter. This self-administered inventory is composed of four subscales with three questions each. Using a 7-point Likert scale, participants choose the answer which they feel most represents the extent to which a statement is true of them (1=not at all true of me, 7=very true of me), at the particular time. Scores are obtained by averaging the Likert scaled responses for each of the 3-questions relative to each subscale, resulting in one score for each of the four subscales. The 12-item AGQ has been used with first year psychology college students (Elliot & McGregor, 2001), and freshmen college students (Finney, Pieper, & Barron, 2004); however use of this instrument with medical students has not been reported.

Reported exploratory Factor Analysis (EFA), resulted in a factor solution which accounted for 81.5% of the total variance (Elliot & McGregor, 2001); averaged responses for each factor showed internal reliability shown by Cronbach’s α values: Mastery-approach goals, .87; Mastery-avoidance goals, .89; Performance-approach goals, .92; and Performance-avoidance goals, .83. Scores obtained on the four achievement goal subscales
showed reliability and internal consistency (Elliot & McGregor, 2001). A psychometric analysis for the current study is provided in the Results section.

**Metacognitive Awareness Inventory (MAI).** The 52-item Metacognitive Awareness Inventory (MAI) (Schraw & Dennison, 1994) was used to measure the construct *metacognitive monitoring*. The MAI contains eight subscales: declarative knowledge, procedural knowledge, conditional knowledge, planning, information strategies, monitoring, debugging strategies, and evaluation. Of these, all but information strategies and debugging strategies were employed in this study. These two variables are also addressed in the Approaches to Learning Inventory, described below. These constructs were described in detail in the literature review.

The MAI is a self-administered report, using a binary choice response. Participants choose the answer for each statement which they feel most represents them at this particular time, TRUE if the statement is true of them, and FALSE if the statement is not true of them. Each of the scales produces a participant score that is calculated by assigning a number 1 to each TRUE response, and a zero to each FALSE response. The TRUE responses are counted to calculate the scale score. Participants thus generated six scores corresponding to the six scales: declarative knowledge, procedural knowledge, conditional knowledge, planning, monitoring, and evaluation. The MAI has been reported with college undergraduates and graduate students (Schraw & Dennison, 1994; Young & Fry, 2008), but not reported with medical students.

Reported exploratory Factor Analysis resulted in a two-factor solution, Knowledge of Cognition (declarative, procedural, conditional knowledge) and Regulation of Cognition (planning, information management, monitoring, debugging, evaluation) (Schraw &
Internal reliability Cronbach’s α values were reported as: Declarative knowledge, .81; Procedural knowledge, .74; Conditional knowledge, .71; Planning, .66; Monitoring, .65; and Evaluation, .59. Coefficient α for items loading on either of the two factors reached .91, coefficient α for the entire instrument reached .95 (Schraw & Dennison).

**Approaches to Learning and Studying Inventory (ALSI).** The 18-item Approaches to Learning and Studying Inventory (ALSI) (Mattick, Dennis & Bligh, 2004) was used to measure the construct *approaches to learning*. The inventory is composed of four subscales: SA=Surface Approach, MS=Monitoring Studying, DA=Deep Approach, EMOS=Effort Management, and OS=Organized studying. These constructs were described in the literature review. The ALSI is a self-administered inventory. Using a 5-point Likert scale, participants choose the answer which they feel most represents the extent to which a statement is true of them at the particular time (1=not at all true of me, 5=very true of me). Scores were obtained by averaging the Likert scaled responses for each of the 2-6 questions relative to each subscale, resulting in a score for each of the five variables. The 18-item Approaches to Learning and Studying Inventory (ALSI) has been used and reported with medical students (Abraham, et al, 2008; Mattick, et al, 2004).

Reported confirmatory Factor Analysis (CFA) resulted in a 4-factor model (deep approach, surface approach, monitoring studying, effort management/organized study) (Mattick, et al, 2004). Internal reliability by factor using Cronbach’s α: Deep approach, 0.66; Surface approach, 0.64; Monitoring studying, 0.66; Effort Management, 0.34; Organized Studying, 0.72; and the merged factor, 0.70=Effort Management/Organized Studying.

**Procedures.** Permission was granted to engage medical students in this study by the Associate Dean of Undergraduate Medical Education. An expedited application, including an
Informed Consent, was approved by the HSC Human Research Review Committee (HRRC), # 09-553 (Dec. 8, 2009). A Medical Student Learning Questionnaire specifically assembled from extant instruments for this study was administered to participant volunteers in conjunction with regularly scheduled class time at the medical school. Each student signed the Informed Consent, and coded their questionnaire with their student identification number (ID) or their name if the ID number was unknown. The identification code was used to match their questionnaire responses with demographic and performance data. Students were not required to participate as part of their current course, nor were they offered extra credit for participating. Participants were compensated ($10.00) upon returning the Medical Student Learning Questionnaire and Consent Form.

**Descriptive and Exploratory Data Analyses**

Fourteen (14) sub-scale scores from the Questionnaire were computed for each participant, corresponding with each different variable that was analyzed. Each Questionnaire was reviewed for completion by the researcher when submitted. There were a few unanswered questions (items) on a small number of Questionnaires which were left blank and not counted as responses using listwise analyses. After the subscales were computed, they were screened for out of range values then analyzed for deviations from normality using the Shapiro-Wilk test (SPSS), as well as visually inspecting the histograms and box-and-whisker plots. Results indicated a non-normal distribution with the 14 subscales, showing a strong negative skew in all instances except the ALSI surface approach. Descriptive statistics (means, standard deviations, range, skewness, kurtosis, and alpha values) were computed for all study variables and are reported in Table 3.
Table 3  
*Descriptive Statistics by Subscale.*

<table>
<thead>
<tr>
<th>Variable</th>
<th># questions</th>
<th>Mean Score</th>
<th>Standard Deviation</th>
<th>Range Possible</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>PApp</td>
<td>3</td>
<td>13.38</td>
<td>4.55</td>
<td>3-21</td>
<td>-.646</td>
<td>-.067</td>
<td>.921</td>
</tr>
<tr>
<td>MApp</td>
<td>3</td>
<td>17.86</td>
<td>2.73</td>
<td>3-21</td>
<td>-.844</td>
<td>.164</td>
<td>.834</td>
</tr>
<tr>
<td>PAv</td>
<td>3</td>
<td>12.33</td>
<td>4.88</td>
<td>3-21</td>
<td>-.015</td>
<td>-.822</td>
<td>.814</td>
</tr>
<tr>
<td>MAv</td>
<td>3</td>
<td>14.75</td>
<td>4.13</td>
<td>3-21</td>
<td>-.631</td>
<td>-.006</td>
<td>.862</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th># questions</th>
<th>Mean Score</th>
<th>Standard Deviation</th>
<th>Range Possible</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>DK</td>
<td>8</td>
<td>6.16</td>
<td>1.69</td>
<td>0-8</td>
<td>-.5</td>
<td>.038</td>
<td>.649</td>
</tr>
<tr>
<td>PK</td>
<td>4</td>
<td>3.35</td>
<td>0.83</td>
<td>0-4</td>
<td>1.25</td>
<td>1.26</td>
<td>.386</td>
</tr>
<tr>
<td>CK</td>
<td>6</td>
<td>4.88</td>
<td>1.04</td>
<td>0-6</td>
<td>-1.04</td>
<td>2.11</td>
<td>.274</td>
</tr>
<tr>
<td>P</td>
<td>7</td>
<td>4.29</td>
<td>1.73</td>
<td>0-7</td>
<td>1.22</td>
<td>7.18</td>
<td>.556</td>
</tr>
<tr>
<td>M</td>
<td>7</td>
<td>5.35</td>
<td>1.56</td>
<td>0-7</td>
<td>-.734</td>
<td>-3.61</td>
<td>.578</td>
</tr>
<tr>
<td>E</td>
<td>6</td>
<td>.633</td>
<td>.263</td>
<td>0-6</td>
<td>-.473</td>
<td>-6.68</td>
<td>.545</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th># questions</th>
<th>Mean Score</th>
<th>Standard Deviation</th>
<th>Range Possible</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA</td>
<td>6</td>
<td>22.30</td>
<td>3.57</td>
<td>6-30</td>
<td>-.082</td>
<td>-.047</td>
<td>.706</td>
</tr>
<tr>
<td>SA</td>
<td>4</td>
<td>7.53</td>
<td>2.25</td>
<td>3-15</td>
<td>.479</td>
<td>.147</td>
<td>.642</td>
</tr>
<tr>
<td>MS</td>
<td>4</td>
<td>15.63</td>
<td>2.35</td>
<td>4-20</td>
<td>-.296</td>
<td>-.378</td>
<td>.619</td>
</tr>
<tr>
<td>EMOS</td>
<td>4</td>
<td>14.29</td>
<td>3.42</td>
<td>4-20</td>
<td>-.525</td>
<td>.038</td>
<td>.753</td>
</tr>
</tbody>
</table>


**Reliability.** Using the full participant pool, Cronbach’s alpha co-efficient was computed for all subscales and is reported in Table 3. As indicated, Cronbach’s alpha values for the Achievement Goals Questionnaire are high (range=.814-.921), and for the Approaches to Learning Inventory are medium to high (range=.619-.753). The Metacognitive Awareness Inventory shows low alphas (range=.274-.649). This issue is addressed separately below.

Exploratory Factor Analysis (EFA) was conducted on each subscale using the correlation matrix and Principal Axis Factoring (PAF) as the extraction method, and Varimax
with Kaiser Normalization as the rotation method. The Achievement Goals measure showed a 4-factor solution accounting for 70.10% of the total variance; a result corresponding favorably with the reported 4-factor solution and variance of 81.5% (Elliot & McGregor, 2001, p. 503). The 4-factor solution for the Approaches to Learning measure accounted for 39.9% of total variance, compared with a reported 4-factor solution using Confirmatory Factor Analysis (CFA) (Mattick, Dennis & Bligh, 2004). Of note is the 13-factor solution for the MAI, accounting for 46.8% of the total variance. This result contrasts sharply with the reported 2-factor solution and 65% variance reported (Schraw & Dennison, 1994, p. 464), and was cause for a major rethinking of the analysis (See Appendix B for a listing of factor loadings).

**Change in analysis.** Two of the *Questionnaire’s* scales, Achievement Goal Questionnaire (AGQ) and Approaches to Learning Inventory (ALSI), showed reliability and factor analysis values as expected and comparable to published reports. Results with the Metacognitive Awareness Inventory (MAI) were not as expected, showing low reliability values and an unusually large number of emergent factors, in contrast to published reports. Reliability and factor analysis values reported by the MAI authors indicated reliability values from a low of .59 (Evaluation subscale) to a high of .81 (Declarative Knowledge subscale), resulting in a two-factor solution of Knowledge of Cognition and Regulation of Cognition (Schraw & Dennison, 1994). In the current study, however, reliability values were recorded from a low of .27 (Conditional Knowledge subscale) to a high of .64 (Declarative Knowledge subscale), with a 13-factor solution.

This result raised significant questions about the utility and desirability of further analysis using the MAI data. The reliability and factor analytic results obtained with this
medical student sample could be attributed to several considerations. For example, the
dichotomous nature of the instrument’s scoring procedure may have made it easier to choose
the more “socially desirable” answer. Perhaps professional and graduate students have
trained themselves over time to at least occasionally use the behavioral and cognitive
learning skills addressed in the MAI. Even if students do not always engage in the particular
learning behaviors implied by the MAI questions, they may recognize the intent of the
question and answer accordingly. Further, the reported skewness of the participant sample
described earlier suggests the potential for ceiling effects occurring with the MAI. A ceiling
effect would suggest that with this sample there was not enough difference among MAI
scores to show clear distinction between participant results (Cisneros, 2009; Copeland &
Hewson, 2000; Harvey, Rothman, & Frecker, 2003). The percentage of affirmative answers
provided by the participants in this study for the MAI was only slightly over half at 59.94%,
indicating that the instrument was able to manifest some discrimination in scoring.
Additionally, for the total participant pool of 204, very few comments were recorded relative
to the MAI questions, and none in terms of ambiguity or confusion. Typical recorded
responses related to a specific question included: “depends on block,” “depends on
instructor,” “try to,” and a couple ampersands to highlight the True answer choice. The
conclusion is that participants understood what was asked with the MAI questions and
answered accordingly. Schraw and Dennison (1994) describe the MAI as “—suitable for
adolescents and adults” (Schraw & Dennison, p. 461), and conclude that “the MAI provides a
reliable initial test of metacognitive awareness among older students” (Schraw & Dennison,
p. 472). Although the constructs measured by the MAI were expected to track well with a
medical student sample, there was a notable difference between the medical student
population and the first year college undergraduates described by Schraw & Dennison (1994).

Based on the difficulties encountered with the MAI instrument with the medical student population, the measure was removed from inclusion in further analysis. Implications for this change in analyses are that Research Questions #2 and #3 will not be addressed and #7 will be altered to reflect the omission of the MAI instrument constructs.
Results

In this chapter each research question is addressed sequentially, including a description of the analyses undertaken and results obtained. Seven research questions are described (two questions were eliminated because of the above mentioned reliability issues with the MAI measure, and one was added). While the threat of a family-wise error due to multiple tests exists, the Bonferroni adjustment was deemed an overly conservative response. Rather, an alpha level of .01 was used throughout instead of .05, except where noted.

The first step was to establish the broad relationship between the AGQ and ALSI measures as a foundation for conducting and understanding the remaining analyses. The first research questions addressed include: RQ #1: How do the achievement goals subscales relate to the approaches to learning subscales? and RQ #7: Which subscales in the Achievement Goals measure are more predictive of one of the subscales of the Approaches to Learning & Studying measure?

The Achievement Goals Questionnaire (AGQ) and the Approaches to Learning and Studying Inventory (ALSI) are the two measures under analysis in this chapter. Each measure is composed of four subscales (AGQ: performance-approach, mastery-avoidance, mastery-approach, performance-avoidance; and the ALSI: surface approach, monitoring studying, deep approach, and effort management/organized studying). To discover how the achievement goals (AGQ) subscales relate to the approaches to learning (ALSI) subscales, a matrix of Pearson Product-Moment Correlation Coefficients was constructed. Results are shown in Table 4 along with means, standard deviations and subscale reliability coefficients.
Table 4
Pearson Product-Moment Correlations and Descriptive Statistics for the Achievement Goals and Approaches to Learning Subscales.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Performance Approach</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-Mastery Avoidance</td>
<td>.153</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-Mastery Approach</td>
<td>.090</td>
<td>.320**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-Performance Avoidance</td>
<td>.095</td>
<td>.257**</td>
<td>-.005</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-Surface Approach</td>
<td>.046</td>
<td>.307**</td>
<td>-.058</td>
<td>.248**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-Monitoring Studying</td>
<td>.121</td>
<td>.036</td>
<td>.389**</td>
<td>-.004</td>
<td>-.268**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-Deep Approach</td>
<td>.066</td>
<td>.052</td>
<td>.372**</td>
<td>-.019</td>
<td>-.241**</td>
<td>.549**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-Effort Management/ Organized Studying</td>
<td>.232**</td>
<td>.028</td>
<td>.304**</td>
<td>-.042</td>
<td>-.261**</td>
<td>.271**</td>
<td>.148</td>
<td></td>
</tr>
</tbody>
</table>

Mean                  | 13.39| 14.75| 17.87| 12.33| 7.53 | 15.64| 22.31| 14.30|
SD                    | 4.56 | 4.14 | 2.73 | 4.89 | 2.25 | 2.35 | 3.58 | 3.42 |
Cronbach’s Alpha      | .92  | .86  | .83  | .81  | .64  | .62  | .71  | .75  |

Note. ** p < .01 (2-tailed).

Correlations for the AGQ and ALSI subscales are shown in the matrix (related to RQ #1). The significant relationship found between mastery-approach and mastery-avoidance goals, performance-avoidance and mastery-avoidance goals, surface approach strategies and mastery-avoidance goals were expected; as were the significant relationships between monitoring studying strategies and mastery-approach goals, deep approach strategies and mastery-approach goals, and effort management/organized studying strategies and mastery-approach goals. The ALSI learning strategy subscales of monitoring studying, deep approach, and effort management/organized studying are also seen to have a significant negative relationship with the surface approach strategy. Deep approach and effort management/organized studying learning strategies also have a significant positive relationship with the monitoring studying learning strategy.

Predictions are possible based on these AGQ and ALSI subscale correlations (related to RQ #7) in terms of probability of engaging in certain types of learning behavior based on the type of achievement goals held. As shown in Table 4, mastery-approach and mastery-
avoidance achievement goal subscales significantly predicted several of the ALSI subscales. A medical student who holds mastery-approach achievement goals is likely to engage in a constellation of related and favorable learning strategies which include: the deep learning approach, monitoring studying and effort management/organized studying strategies. Students holding a mastery-avoidance achievement goal, however, are less likely to engage in these deeper processing strategies and more likely to engage in surface approach information processing learning strategies. Therefore, the achievement goal of mastery-approach is most predictive of engagement in ALSI subscale learning behaviors.

This information allows for several conclusions about medical student learning behavior, which can be characterized as follows:

- The more mastery-approach oriented a medical student’s goals for learning are, the more likely she is also to monitor her study, employ deep approaches to processing information, manage her effort, and organize her studying.
- The more performance-avoidance oriented a medical student’s goals for learning are, the more likely he is to employ surface approaches to processing information.
- The more performance-approach oriented a medical student’s goals for learning are, the more likely he is to also engage in managing learning effort, and organizing his study.
- The more a medical student engages in deep approaches to processing information, the more likely she also is to monitor her studying.
- The more a medical student engages in managing and organizing his studying, the more likely he is also to monitor his study.
• The more a medical student is engaged in monitoring her studying, the less likely she is also to be engaged in a surface approach to processing information.

• The more a medical student is engaged in managing and organizing his study efforts, the less likely he is also to be engaged in a surface approach to processing information.

• The more a medical student is engaged in deep processing of information to be learned, the less likely she is to also employ surface approaches to processing information.

• The more a medical student is engaged in deep processing of information to be learned, the more likely he is to also employ the additional learning strategies of effort management/organized studying and monitoring studying.

The achievement goals valence dimension, which identifies an approach or avoidance orientation, can be seen to “crossover” achievement goal categories. For example, students holding performance-avoidance goals may also hold mastery-avoidance goals. This exemplifies the actual nature of achievement goal theory in that students can hold a number of achievement goals at once although one achievement goal and valence for that goal will predominate in a learning situation. Although mastery-approach and mastery-avoidance achievement goals are moderately correlated, as expected based on the shared mastery goal construct, they do not correlate with the same information processing strategies. That is, students holding mastery-approach goals are much more likely to employ the learning strategies of deep approach, monitoring studying, managing effort, and organizing studying. Mastery-avoidance was not significantly related to any learning strategies, but showed a significant relationship with the performance-avoidance achievement goal. Medical students
holding an avoidance valence for learning, whether with mastery or performance goals, can be expected to engage in surface approaches to learning processing, learning behaviors which do not include managing effort, organizing studying, or monitoring study effort.

The nature of the relationship of the eight subscales with several demographic and performance variables was explored next. The research question addressed is RQ #4: Do the categorical demographic variables of gender, ethnicity, and undergraduate major, and the continuous variables of age and undergraduate GPA have a relationship with the Achievement Goals and Approaches to Learning subscales? [RQ #2 and #3 were not addressed due to the reliability issues encountered with the MAI].

**Gender**

Independent samples t-tests were performed to determine the relationship of gender to the eight subscales, for which means (standard deviation), t value, significance levels and effect sizes are indicated in Table 5.

**Table 5**

*Differences between Genders Regarding the Eight Subscales.*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Female M (SD)</th>
<th>Male M (SD)</th>
<th>t (200)</th>
<th>Sig</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approach</td>
<td>13.50 (4.58)</td>
<td>13.20 (4.60)</td>
<td>.447</td>
<td>.655</td>
<td>.06</td>
</tr>
<tr>
<td>Mastery</td>
<td>15.16 (4.12)</td>
<td>14.29 (4.14)</td>
<td>1.48</td>
<td>.140</td>
<td>.21</td>
</tr>
<tr>
<td>Avoidance</td>
<td>18.30 (2.46)</td>
<td>17.33 (2.97)</td>
<td>2.54</td>
<td>.012</td>
<td>.35</td>
</tr>
<tr>
<td>Mastery</td>
<td>12.66 (4.78)</td>
<td>11.87 (4.96)</td>
<td>1.15</td>
<td>.25</td>
<td>-.03</td>
</tr>
<tr>
<td>Avoidance</td>
<td>7.53 (2.04)</td>
<td>7.60 (2.50)</td>
<td>-.224</td>
<td>.823</td>
<td>-.03</td>
</tr>
<tr>
<td>Monitoring</td>
<td>15.54 (2.36)</td>
<td>15.70 (2.34)</td>
<td>-.500</td>
<td>.618</td>
<td>-.07</td>
</tr>
<tr>
<td>Deep</td>
<td>21.97 (3.27)</td>
<td>22.70 (3.88)</td>
<td>-1.46</td>
<td>.146</td>
<td>-.21</td>
</tr>
<tr>
<td>Effort Mgmt</td>
<td>14.86</td>
<td>13.50</td>
<td>2.84**</td>
<td>.005</td>
<td>.40</td>
</tr>
</tbody>
</table>
Organized Studying (3.08) (3.70) 

Note: ** p < .01

The *t*-tests were conducted to evaluate to what extent the variable gender impacts the AGQ or ALSI subscale scores. The *t*-statistic was significant on only one subscale. Effort management/organized studying showed a significant relationship with gender *t* (200) = 2.843, *p* = .005, with a small effect size, Cohen’s *d* = .40. This outcome indicates that female students, with a statistically significant higher mean average on the subscale, show a greater likelihood of engaging in effort management/organized studying strategies than do male students.

**Ethnicity**

Analysis of variance was used to determine the nature of the relationship between ethnicity and the eight subscales. Eight one-way ANOVAs were performed, for which means (standard deviations), F and significance values are indicated in Table 6.

Results showed a significant relationship with the AGQ performance-approach subscale and ethnicity *F* (4, 179) = 4.57, *MSe = 19.756, p = .002, eta squared .117. The Tukey HSD post hoc multiple comparison procedure was used to test differences between groups, and a significant difference was found between Anglo and African American students on performance-approach, Tukey HSD, 9.816, *p* = .002, 99% CI [1.2013, 18.4299]. Results indicate that in this sample Anglo students are more likely than African American students to hold performance-approach achievement goals in medical school.
Table 6
Differences among Ethnic groups regarding the Eight Subscales.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Anglo N=94</th>
<th>Hispanic N=60</th>
<th>Native American N=14</th>
<th>African American N=3</th>
<th>Asian N=13</th>
<th>Totals N=184</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastery Avoidance</td>
<td>15.2447 (3.90)</td>
<td>15.0833 (3.743)</td>
<td>15.1071 (3.43)</td>
<td>7.6667 (3.06)</td>
<td>15.0769 (5.09)</td>
<td>15.0462 (3.98)</td>
<td>F (4,179) = 2.747</td>
<td>.030</td>
</tr>
<tr>
<td>Mastery Approach</td>
<td>17.7553 (2.75)</td>
<td>18.4500 (2.39)</td>
<td>17.0714 (3.79)</td>
<td>17.3333 (3.21)</td>
<td>18.2308 (2.09)</td>
<td>17.9565 (2.70)</td>
<td>F (4,179) = 1.086</td>
<td>.365</td>
</tr>
<tr>
<td>Surface Approach</td>
<td>7.5160 (2.22)</td>
<td>7.4500 (2.14)</td>
<td>8.2500 (3.10)</td>
<td>7.2500 (2.41)</td>
<td>8.4808 (2.48)</td>
<td>7.6141 (2.29)</td>
<td>F (4,179) = .875</td>
<td>.480</td>
</tr>
<tr>
<td>Monitoring Studying</td>
<td>15.7766 (2.30)</td>
<td>15.6222 (2.41)</td>
<td>15.5714 (2.59)</td>
<td>15.6667 (3.79)</td>
<td>14.1538 (2.23)</td>
<td>15.5942 (2.38)</td>
<td>F (4,179) = 1.336</td>
<td>.258</td>
</tr>
<tr>
<td>Deep Approach</td>
<td>22.3745 (3.48)</td>
<td>22.2333 (3.27)</td>
<td>23.2143 (4.48)</td>
<td>24.6667 (5.51)</td>
<td>20.8462 (3.65)</td>
<td>22.3217 (3.54)</td>
<td>F (4,179) = 1.132</td>
<td>.343</td>
</tr>
<tr>
<td>Effort Mgt/Organized Studying</td>
<td>14.4043 (3.42)</td>
<td>14.5167 (3.27)</td>
<td>13.5714 (3.84)</td>
<td>12.0000 (3.61)</td>
<td>13.2308 (2.80)</td>
<td>14.2554 (3.36)</td>
<td>F (4,179) = .920</td>
<td>.454</td>
</tr>
</tbody>
</table>

Note. ** p < .01.

In medical education research, especially those involving program funding from the Health Resources & Services Administration (HRSA), Department of Health and Human Services (DHHS), ethnic groups are delineated according to “underrepresented minority” (URM) (in this study sample, Hispanic, Native American, and African American), and “non-underrepresented minority” (non-URM) (in this study, Anglo and Asian). To see if the results obtained and described above would differ using the URM and non-URM categories, an independent samples t-test was performed. Results indicating means (standard deviations), t, significance, and effect size values are shown in Table 7.
Table 7
Differences between URM and non-URM Students regarding the Eight Subscales.

<table>
<thead>
<tr>
<th>Variable</th>
<th>URM</th>
<th>M (SD)</th>
<th>Non-URM</th>
<th>M (SD)</th>
<th>t (182)</th>
<th>Sig</th>
<th>Cohen's d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Approach</td>
<td>12.18</td>
<td>(4.61)</td>
<td>13.99</td>
<td>(4.49)</td>
<td>-2.68**</td>
<td>.008</td>
<td>-0.40</td>
</tr>
<tr>
<td>Mastery Avoidance</td>
<td>14.80</td>
<td>(3.90)</td>
<td>15.22</td>
<td>(4.04)</td>
<td>-.715</td>
<td>.475</td>
<td>-0.11</td>
</tr>
<tr>
<td>Mastery Approach</td>
<td>18.16</td>
<td>(2.74)</td>
<td>17.81</td>
<td>(2.67)</td>
<td>.850</td>
<td>.396</td>
<td>0.13</td>
</tr>
<tr>
<td>Performance Avoidance</td>
<td>13.08</td>
<td>(4.62)</td>
<td>11.79</td>
<td>(4.50)</td>
<td>1.79</td>
<td>.075</td>
<td>0.28</td>
</tr>
<tr>
<td>Surface Approach</td>
<td>7.59</td>
<td>(2.33)</td>
<td>7.63</td>
<td>(2.26)</td>
<td>-.133</td>
<td>.894</td>
<td>-0.02</td>
</tr>
<tr>
<td>Monitoring Studying</td>
<td>15.61</td>
<td>(2.46)</td>
<td>15.58</td>
<td>(2.34)</td>
<td>.099</td>
<td>.921</td>
<td>0.01</td>
</tr>
<tr>
<td>Deep Approach</td>
<td>22.51</td>
<td>(3.59)</td>
<td>22.19</td>
<td>(3.52)</td>
<td>.599</td>
<td>.550</td>
<td>0.09</td>
</tr>
<tr>
<td>Effort Mgt/Organized Studying</td>
<td>14.25</td>
<td>(3.39)</td>
<td>14.26</td>
<td>(3.36)</td>
<td>-.030</td>
<td>.976</td>
<td>-0.00</td>
</tr>
</tbody>
</table>

Note: ** p < .01

As indicated in the table, non-URM students hold stronger performance-approach achievement goals than URM students do, \( t (182) = -2.676, p = .008 \), with a small effect size, Cohen's \( d = -0.40 \). Otherwise, URM students have approximately the same levels of achievement goals and approaches to learning as their non-URM counterparts, an overall result which implies that these constructs are not useful for explaining URM performance decrements.

Undergraduate Major

Academic thinking develops in conjunction with the requirements and modes of thinking and problem solving particular to the discipline being studied. Therefore, a student's undergraduate major is expected to offer insight into the achievement goals and approaches to learning employed by a student in medical school. For ease of analysis, the 52 majors
identified for the participant sample were distilled into seven categories: biological science (biology, biochemistry, biomed); physical sciences (chemistry, physics); social science (sociology, psychology, anthropology); humanities (English, foreign language, communication, philosophy); engineering (chemical, mechanical); and health (pre-medical, nursing, medical technology). The majority of the sample’s medical students majored in biology as undergraduates, followed by biochemistry, and then a selection of physical, biological, social science, humanities and combined majors. The pre-medical curriculum is expected to be variable nonetheless this sample clearly leans toward biology as the preferred major. Analysis of variance was employed to address the question of whether or not there is a relationship between the various undergraduate major categories and the eight subscales. The eight subscales were entered as the dependent variables and undergraduate major entered as the independent variable. Means (standard deviations), Mean square, F, and significance values for each of the eight subscales and the seven undergraduate major categories are indicated in Table 8.

Results indicate no statistically significant findings among the undergraduate major variable and the eight subscales.
Table 8
Differences among Seven Undergraduate Major Categories regarding the Eight Subscales.

<table>
<thead>
<tr>
<th>Variable</th>
<th>1 N=131</th>
<th>2 N=9</th>
<th>3 N=17</th>
<th>4 N=6</th>
<th>5 N=14</th>
<th>6 N=9</th>
<th>7 N=18</th>
<th>Totals N=204</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastery Approach</td>
<td>18.00</td>
<td>17.77</td>
<td>16.88</td>
<td>17.50</td>
<td>17.07</td>
<td>18.88</td>
<td>18.05</td>
<td>17.86 (2.73)</td>
<td>.864</td>
<td>.523</td>
</tr>
<tr>
<td>Performance Avoidance</td>
<td>12.69</td>
<td>12.44</td>
<td>12.00</td>
<td>11.58</td>
<td>11.42</td>
<td>12.77</td>
<td>10.66</td>
<td>12.33 (4.48)</td>
<td>.593</td>
<td>.736</td>
</tr>
<tr>
<td>Surface Approach</td>
<td>7.45 (2.17)</td>
<td>7.41 (2.44)</td>
<td>8.64 (2.61)</td>
<td>8.25 (1.64)</td>
<td>7.60 (2.59)</td>
<td>7.58 (1.81)</td>
<td>6.79 (2.39)</td>
<td>7.53 (2.23)</td>
<td>1.155</td>
<td>.332</td>
</tr>
<tr>
<td>Monitoring Studying</td>
<td>15.61 (2.38)</td>
<td>15.00 (3.00)</td>
<td>15.37 (1.70)</td>
<td>15.66 (1.63)</td>
<td>15.07 (2.70)</td>
<td>15.55 (1.50)</td>
<td>16.88 (2.39)</td>
<td>15.63 (2.33)</td>
<td>1.142</td>
<td>.340</td>
</tr>
<tr>
<td>Deep Approach</td>
<td>22.01 (3.48)</td>
<td>22.33 (3.87)</td>
<td>21.41 (2.95)</td>
<td>23.20 (3.44)</td>
<td>21.85 (3.99)</td>
<td>23.11 (3.44)</td>
<td>24.94 (3.76)</td>
<td>22.30 (3.57)</td>
<td>2.206</td>
<td>.044</td>
</tr>
<tr>
<td>Effort Mgt/ Organized Studying</td>
<td>14.48 (3.36)</td>
<td>14.00 (3.67)</td>
<td>12.41 (2.76)</td>
<td>12.16 (5.49)</td>
<td>15.00 (2.98)</td>
<td>15.44 (4.47)</td>
<td>14.44 (2.79)</td>
<td>14.29 (3.42)</td>
<td>1.630</td>
<td>.141</td>
</tr>
</tbody>
</table>

Note. **p < .01. Key: 1) Biological Science; 2) Physical Science; 3) Social Science; 4) Humanities; 5) Engineering; 6) Health; and 7) Other.

Age at Matriculation

Two multiple regression analyses were used to see if age at matriculation would be significantly predicted by any of the AGQ or ALSI subscales, and to independently calculate the R square statistic for each of the two measures. The dependent variable was age at matriculation, and the independent variable was entered in the first multiple regression as the four AGQ subscales and in the second multiple regression as the four ALSI subscales.

Results indicating Beta, t, and significance values are shown in Table 9.
Table 9
*Age at Matriculation and the AGQ Subscales, and Age at Matriculation and the ALSI Subscales.*

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>t</th>
<th>Sig</th>
<th>CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Approach</td>
<td>-.153</td>
<td>-2.167</td>
<td>.031</td>
<td>[-.217, -.014]</td>
</tr>
<tr>
<td>Mastery Avoidance</td>
<td>-.020</td>
<td>-.258</td>
<td>.796</td>
<td>[-.120, .127]</td>
</tr>
<tr>
<td>Mastery Approach</td>
<td>.074</td>
<td>1.002</td>
<td>.318</td>
<td>[-.212, .184]</td>
</tr>
<tr>
<td>Performance Avoidance</td>
<td>-.131</td>
<td>-1.807</td>
<td>.072</td>
<td>[-.210, .024]</td>
</tr>
<tr>
<td>Surface Approach</td>
<td>-.112</td>
<td>-1.531</td>
<td>.127</td>
<td>[-.316, .139]</td>
</tr>
<tr>
<td>Monitoring Studying</td>
<td>-.145</td>
<td>-1.698</td>
<td>.091</td>
<td>[-.412, .068]</td>
</tr>
<tr>
<td>Deep Approach</td>
<td>.281</td>
<td>3.386**</td>
<td>.001</td>
<td>[.109, .421]</td>
</tr>
<tr>
<td>Effort Management/</td>
<td>-.012</td>
<td>-.168</td>
<td>.866</td>
<td>[-.117, .174]</td>
</tr>
<tr>
<td>Organized Studying</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mean               24.78
SD                 3.35
Range              20 (21-41)

Note. ** p < .01. CI = Confidence Interval [Lower Bound, Upper Bound].

Age at matriculation was not significantly predicted by the Achievement Goals measure (performance-approach, mastery-avoidance, mastery-approach, performance-avoidance), F (4, 197) = 2.566, p = .039, with an R squared value of .050, indicating that the AGQ subscales did not significantly explain variation in age at matriculation. In contrast, age at matriculation was significantly predicted by the deep approach subscale, t = 3.386, p = .001 of the Approaches to Learning measure (surface approach, monitoring studying, deep approach, and effort management/organized studying), F (4, 197) = 3.876, p = .005. However, an R squared value of .073 indicated that the ALSI subscales as a whole did not significantly explain variation in age at matriculation.

**Undergraduate GPA**

Two multiple regression analyses were used to see if undergraduate GPA would be significantly predicted by any of the AGQ or ALSI subscales, and to independently calculate the R square statistic for each of the two measures. The dependent variable was undergraduate GPA; the independent variable was
the four AGQ subscales and in the second multiple regression as the four ALSI subscales.

Results indicating Beta, $t$, and significance values are shown in Table 10.

**Table 10**

*Undergraduate GPA and the AGQ Subscales and Undergraduate GPA and the ALSI Subscales.*

<table>
<thead>
<tr>
<th>Performance Approach</th>
<th>B</th>
<th>$t$</th>
<th>Sig</th>
<th>CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastery Avoidance</td>
<td>.046</td>
<td>.559</td>
<td>.577</td>
<td>[.008, .014]</td>
</tr>
<tr>
<td>Mastery Approach</td>
<td>.046</td>
<td>.530</td>
<td>.597</td>
<td>[.013, .023]</td>
</tr>
<tr>
<td>Performance Avoidance</td>
<td>-.041</td>
<td>-.537</td>
<td>.592</td>
<td>[.011, .006]</td>
</tr>
</tbody>
</table>

| Surface Approach     | -.026 | .313    | .754  | [.024, .017]    |
| Monitoring Studying  | -.032 | -.349   | .727  | [.025, .018]    |
| Deep Approach        | -.105 | -1.180  | .239  | [.022, .006]    |
| Effort Management/   | .053  | .669    | .504  | [.009, .017]    |
| Organized Studying   |       |         |       |                 |

Mean (UND GPA) 3.601
SD (UND GPA) .283
Range (UND GPA) 1.48 (2.52-4.0)

Note. ** p < .01. CI=Confidence Interval, [Lower Bound, Upper Bound].

Undergraduate GPA was not significantly predicted by any of the eight subscales, with an $R$ squared value of .02 confirming this outcome. This result indicates that undergraduate GPA is not directly associated with learning behaviors as measured by the AGQ and ALSI.

The next analysis looked for the extent of mean differences between the three classes of medical students on the eight subscales. The research question addressed is RQ #5: Are there mean differences among Achievement Goals and Approaches to Learning for first, second, and third year students?

Analysis of variance (ANOVA) was conducted to determine if there was a significant difference in mean subscale scores between the three medical school classes on the study’s eight subscales. Eight one way ANOVAs were conducted using scores from the three
different classes (independent variable) and the eight subscales (dependent variables).

Results showing means, (standard deviation), F and significance values are listed in Table 11.

**Table 11**

*Differences between Three Classes of Medical Students regarding the Eight Subscales.*

<table>
<thead>
<tr>
<th>Variable</th>
<th>First</th>
<th>Second</th>
<th>Third</th>
<th>Total</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastery Approach</td>
<td>18.571 (2.637)</td>
<td>17.703 (2.463)</td>
<td>17.445 (2.908)</td>
<td>17.868 (2.732)</td>
<td>F (2, 201) = 3.246</td>
<td>.041</td>
</tr>
<tr>
<td>Surface Approach</td>
<td>7.679 (2.540)</td>
<td>7.318 (1.965)</td>
<td>7.582 (2.230)</td>
<td>7.536 (2.254)</td>
<td>F (2, 201) = .418</td>
<td>.659</td>
</tr>
<tr>
<td>Monitoring Studying</td>
<td>16.016 (2.317)</td>
<td>15.650 (2.442)</td>
<td>15.342 (2.295)</td>
<td>15.639 (2.350)</td>
<td>F (2, 201) = 1.474</td>
<td>.231</td>
</tr>
</tbody>
</table>

Note. **p < .01

A statistically significant difference was found between the three classes of students only with the mastery-avoidance achievement goal measure. The Bonferroni multiple comparison procedure showed a statistically significant mean difference between first and third year students on the mastery-avoidance subscale, MD = 2.690, p < .01, as well as separately measuring a moderate effect size, Cohen’s $d = 0.6812$. Results indicate that students generally enter medical school with similar achievement goals and approaches to learning, and hold these goals and strategies throughout medical school, despite the third year change in curriculum with the transfer to clinical training. That first year students hold higher levels of mastery-avoidance than third year students is expected, since the students are new
to the whole medical education environment and have yet to prove themselves in that environment.

Analyses were then performed to determine if a third variable could be found to mediate the relationship between the premedical academic performance variable, MCAT score, and the medical school academic performance variable, Phase 1 GPA. The research question addressed is RQ #6: Is the relationship between the variables MCAT score and medical school Phase I GPA [second and third year students] mediated by any of the eight subscale scores?

Taking the eight subscales composing the AGQ and ALSI measures as indicators of learning attitudes and behaviors, a general model was proposed and tested that searches for an intervening variable from either the AGQ or ALSI subscales in the relationship between pre-matriculation academic performance, as shown by the MCAT score, and medical school academic performance, as shown by the Phase 1 GPA (P1GPA), earned at the conclusion of the first 16 months of medical school. Analyses were performed for second and third year students (first year students were excluded from these analyses as they have not yet accumulated a P1GPA).

Could one of the AGQ subscales, performance-approach, performance-avoidance, mastery-approach, mastery-avoidance, or ALSI subscales, surface learning strategy, deep learning strategy, monitoring studying learning strategy, and the effort management/organized studying strategy be found to mediate the relationship between MCAT and P1GPA? A hierarchical multiple regression analysis was conducted. Using P1GPA as the dependent variable, the first block used MCAT score as the independent variable, the second block used MCAT score and all the AGQ and ALSI subscales as
independent variables. The third block used MCAT score, all the AGQ and ALSI subscales, and a new set of variables consisting of MCAT score multiplied by a centered value for each of the AGQ and ALSI subscales as the independent variables.

Steps in the multiple regression analyses follow:

- Model 1. The multiple regression procedure was performed to determine if the independent variable MCAT was a significant predictor of the dependent variable P1GPA. This was an expected relationship therefore forced entry was used for variable entry. Results, shown in Table 12 did indicate that the independent variable, MCAT, was a significant predictor of the dependent variable (P1GPA).

- Model 2. The multiple regression procedure was performed with P1GPA as the dependent variable, and MCAT, along with the eight subscales as the independent variables. Order of entry for these variables was: MCAT, performance-approach, mastery-avoidance, mastery-approach, performance-avoidance, surface approach, monitoring studying, deep approach, effort management/organized studying. Results, shown in Table 12, indicated that two of the independent variables were significant predictors of the dependent variable (P1GPA): MCAT score, and one of the Approaches to Learning variables, effort management/organized studying.

- Model 3. All of the AGQ and ALSI and MCAT scores were centered, and the MCATc score multiplied with each of the AGQc and ALSIc scores. These new variables were included in the third block of the multiple regression. P1GPA was the dependent variable. The order of entry for the independent variables was: MCAT, performance-approach, mastery-avoidance, mastery-approach, performance-avoidance, surface approach, monitoring studying, deep approach, effort
management/organized studying, and the eight new variables (MCATc x AGQc, and MCATc x ALSIc). Results indicated no statistically significant values.

Results for the hierarchical multiple regression indicating $B$ values and confidence intervals, R squared and R squared change values, F and F change values, with P1GPA as dependent variable are indicated in Table 12.

Table 12
Hierarchical Regression Models with P1GPA as the Dependent Variable, MCAT and the Eight Subscales, both Centered and not Centered, as the Independent Variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1 95% CI</th>
<th>Model 2 95% CI</th>
<th>Model 3 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCAT</td>
<td>.439** [.037, .078]</td>
<td>.438** [.038, .077]</td>
<td>-.031 [-.255, .247]</td>
</tr>
<tr>
<td>DA</td>
<td>-.210 [-.058, -.005]</td>
<td>-.880 [-.360, .097]</td>
<td></td>
</tr>
<tr>
<td>MAV</td>
<td>.113 [-.005, .034]</td>
<td>-.477 [-.217, .094]</td>
<td></td>
</tr>
<tr>
<td>EMOS</td>
<td>.390** [.037, .088]</td>
<td>.240 [-.160, .237]</td>
<td></td>
</tr>
<tr>
<td>PApp</td>
<td>-.142 [-.030, .001]</td>
<td>-.316 [-.306, .185]</td>
<td></td>
</tr>
<tr>
<td>PAv</td>
<td>-.027 [-.036, .026]</td>
<td>-.086 [-.349, .307]</td>
<td></td>
</tr>
<tr>
<td>MApp</td>
<td>-.069 [-.059, .024]</td>
<td>-.086 [-.349, .307]</td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td>.068 [-.023, .053]</td>
<td>.826 [-.163, .528]</td>
<td></td>
</tr>
<tr>
<td>MS</td>
<td>.068 [-.023, .053]</td>
<td>.826 [-.163, .528]</td>
<td></td>
</tr>
<tr>
<td>MCATc x SA Ac</td>
<td>.044 [-.033, .035]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCATc x PA vc</td>
<td>-.595 [-.020, .007]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCATc x EMOS Ac</td>
<td>.184 [.023, .031]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCATc x Papp c</td>
<td>.331 [-.012, .019]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCATc x MAv c</td>
<td>.639 [.008, .024]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCATc x MApp c</td>
<td>.341 [-.020, .032]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCATc x MSc c</td>
<td>-.996 [-.072, .025]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCATc x DA c</td>
<td>.931 [-.027, .071]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rsq     | .193 | .436 | .458 |
F       | 31.829** | 10.737** | 5.824** |
Rsq Chg | .193** | .243** | .022 |
F Chg   | 31.829** | 6.729** | .063 |

Note. ** p < .01, CI = confidence interval.

The first requirement to determine an interaction effect of a third variable, is that the variable(s) in question are an independent and significant predictor of the dependent variable, as shown above with MCAT score and the effort management/organized studying ALSI
variable. The second requirement is that significant interaction values are obtained, a requirement which was not met in these analyses. The slopes of MCAT on P1GPA are no different based on any of the eight subscales. Therefore, there is no mediating effect observed.

For this analysis it was necessary to revert to the second step (Model 2) of the hierarchical multiple regression instead of interpreting from the third step, which included the interaction values. The MCAT score, moved from a slope value of .439 in Model 1 (when MCAT was the single independent variable) to .438 in Model 2 (with the eight subscales added), and changed to a much reduced value of -.031 in Model 3 (when the interaction terms were introduced). This outcome suggested that the MCAT score might actually be shared equally among the subscale variables. In any case, there were no interaction values observed, indicating that subscales of the AGQ and ALSI measures do not change the relationship between MCAT score and P1 GPA.

The final analysis was performed to determine if any of the eight subscales in themselves significantly predicted the medical school Phase 1 GPA. The research question addressed is RQ #8: Can one of the Achievement Goals or Approaches to Learning subscales be shown to independently predict the medical school Phase 1 GPA?

The multiple regression procedure was used to determine if there is a predictive relationship between subscales of the AGQ and ALSI measures and medical school Phase 1 GPA (P1GPA). The multiple regression procedure used P1GPA as the dependent variable and the eight subscales as the independent variables, entered as indicated in Table 13. Results indicating Beta, t, and significance values are listed in Table 13.
Table 13
Predictive Relationships between the Achievement Goals and Approaches to Learning Subscales and Phase 1 GPA.

<table>
<thead>
<tr>
<th>Subscale</th>
<th>B</th>
<th>t</th>
<th>Sig</th>
<th>CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Approach</td>
<td>.223</td>
<td>2.76**</td>
<td>.007</td>
<td>[.007, .045]</td>
</tr>
<tr>
<td>Mastery Avoidance</td>
<td>.147</td>
<td>1.71</td>
<td>.089</td>
<td>[-.003, .041]</td>
</tr>
<tr>
<td>Mastery Approach</td>
<td>-.096</td>
<td>-1.05</td>
<td>.296</td>
<td>[-.053, .016]</td>
</tr>
<tr>
<td>Performance Avoidance</td>
<td>-.260</td>
<td>-3.18**</td>
<td>.002</td>
<td>[-.044, -.010]</td>
</tr>
<tr>
<td>Surface Approach</td>
<td>-.117</td>
<td>-1.24</td>
<td>.217</td>
<td>[-.076, .017]</td>
</tr>
<tr>
<td>Monitoring Studying</td>
<td>.025</td>
<td>.260</td>
<td>.795</td>
<td>[-.037, .048]</td>
</tr>
<tr>
<td>Deep Approach</td>
<td>-.157</td>
<td>-1.59</td>
<td>.116</td>
<td>[-.053, .006]</td>
</tr>
<tr>
<td>Effort Management/</td>
<td>.311</td>
<td>3.47**</td>
<td>.001</td>
<td>[.021, .078]</td>
</tr>
<tr>
<td>Organized Studying</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. ** p < .01. CI= Confidence Interval [Lower Bound, Upper Bound].

Although this question was also addressed in RQ #6 related to the mediating variable (in Model 2), results are different in this analysis when withholding the MCAT variable. Results indicate that several of the achievement goals and approaches to learning subscales significantly predict medical school Phase 1 GPA. Specifically, performance achievement goals are seen to significantly predict P1GPA, in both the approach and avoidance valence dimensions. The avoidance dimension, however, shows a significant negative relationship with GPA, while the approach dimension shows a significant positive relationship. The ALSI subscale, effort management/organized studying, is also shown to significantly predict P1GPA.

This outcome indicates that students holding performance-approach achievement goals are more likely to positively reflect their academic achievement in their medical school P1GPA. Similarly, a student holding performance-avoidance achievement goals is more likely to show a negative outcome regarding medical school P1GPA performance. Finally, students who demonstrate an approach to learning that involves managing their study effort
and organizing their studying are more likely to generate a positive outcome relative to medical school P1GPA performance.

**Overview of Significant Findings**

This study approached questions regarding medical students’ learning behavior by examining the relationship between their achievement goals and approaches to learning strategies as measured by the AGQ and ALSI. The following synopsis describes significant findings in terms of student learning practices by research question and the specific variables addressed.

**The relationship of achievement goals (AGQ) and approaches to learning (ALSI) subscales (Research Questions (RQ) # 1 and #7).**

Students holding mastery-approach achievement goals have a greater likelihood of monitoring their study, engaging in deep learning strategies, managing their study effort and organizing their study. Students engaged in a surface learning strategy are less likely to simultaneously engage in the learning strategies of monitoring studying, deep learning strategy, and effort management/organized studying. Students with either performance-approach or mastery-approach achievement goals are likely to compete successfully in medical school. It seems to be the valence which holds most importance for academic success, in that the *approach* valence is associated with the favorable learning strategies of deep learning strategy, monitoring studying, and effort management/organized studying. The *avoidance* valence, in contrast, is associated with surface learning strategies.

**The relationship of gender, ethnicity, undergraduate major, age, and undergraduate GPA to the achievement goals and approaches to learning subscales.**
Gender. Female students are more likely than male students to manage their study effort and organize their studying, though the overall effect size between genders is small.

Ethnicity. Anglo students were more likely to hold performance-approach and mastery-avoidance achievement goals than African American students. Anglo and African American students were more likely than Hispanic and Native American students to engage in monitoring studying strategies. African American students were also more likely to use deep learning strategies than Anglo, Hispanic, and Native American students.

Undergraduate Major. No significant relationships were discovered.

Age at Matriculation. Students who matriculate at a younger age are more likely than their older peers to hold mastery-avoidance achievement goals which suggests the use of surface learning approaches. In other words, a fear of failure may be more prevalent with younger students at matriculation, who may be inclined to use a surface approach to learning to the detriment of deep understanding of the material and building of self regulation learning skills.

Undergraduate GPA. No significant relationships were discovered.

Differences between first, second, and third year students on the eight AGQ and ALSI subscales. First year medical students hold mastery-avoidance achievement goals significantly more often than second or third year students.

Presence of an AGQ or ALSI third variable impacting the relationship between MCAT score and P1GPA. No mediating effect of a third variable was found. The significant relationship between MCAT and P1GPA is based on similar underlying performance characteristics. These academic performance related measures may be more similar to one another than to any of the eight AGQ or ALSI subscale learning behaviors.
Predictive relationship of the AGQ and ALSI subscales relative to Phase 1 GPA.

Performance achievement goals significantly predicted P1GPA, in both the approach and avoidance valence dimensions. The avoidance dimension shows a significant negative relationship with GPA, while the approach dimension shows a significant positive relationship. P1GPA was also significantly predicted by the ALSI subscale of effort management/organized studying.
**Discussion**

Medical education creates challenges and opportunities which impact and inform a student’s goals for learning and choice of learning strategies. Outcomes of this study have implications for medical education practice, for students and educators. The organization of this chapter includes discussion of measures, implications of findings generally, for students, for medical education, and for theory, study limitations, recommendations for future research, and implications for professional practice.

**Measures**

For the purposes of this discussion and to avoid confusion due to similarity in subscale terminology, achievement goals, as measured by the Achievement Goal Questionnaire (AGQ) will be identified as “achievement goals,” and approaches to learning, as measured by the Approaches to Learning and Studying Inventory (ALSI), will be identified as “learning strategies.” The Metacognitive Awareness Inventory (MAI) showed both low reliability values as well as unsatisfactory Exploratory Factor Analysis (EFA) results, leading to its exclusion in further analyses. It was surprising that the measure was not compatible with the medical student population, as reported evidence showed that scores from this inventory were reliable when used with college students (Schraw & Dennison, 1994), and a good measure of students’ metacognitive practices. The two dimensions addressed in the Inventory, Knowledge of Cognition and Regulation of Cognition, are to some extent also addressed with the ALSI variables of monitoring studying and effort management/organized studying which are metacognitive in scope, but unfortunately for this study, did not have the reach and depth that the MAI would have offered.
General Implications of Study Findings

Mastery-approach achievement goals are linked to the learning strategies of monitoring studying, deep learning strategies, effort management and organized studying. Learning environments which encourage these deeper learning strategies are less likely to also accommodate surface learning strategies. Thus, learning environment can be seen to promote and sustain certain types of learning orientation. Moving from the learning environment to the personal level, attending to the valence dimension of a student’s achievement goals may prove a valuable tool for ascertaining a student’s orientation to their learning. The avoidance valence for instance, implies a fear of failure which may manifest as test anxiety or organizational challenges, both of which can be addressed through coaching. The approach valence, in contrast, indicates a readiness to gather resources toward particular learning goals, whether the intent is for advancing graded performance or depth of knowing.

As indicated by results in this study, younger students and first year medical students are both more likely to hold mastery-avoidance achievement goals. However, since no relationship between mastery-avoidance goals and medical school GPA was found, holding these goals alone does not necessarily interfere with positive academic outcome as measured by GPA. What this study did not measure is the subjective experience of learning in a particular environment and how particular achievement goals might facilitate or challenge the learning experience. In this regard, there may be a role for upper-class students in mentoring and role modeling successful orientations to learning in the medical school environment. In fact, many medical schools offer this kind of peer mentoring.

Knowing that female students are more likely to manage and organize their study efforts, might imply that male students should be afforded more explicit instruction in
building these skills early in medical school. However, many students need this kind of instruction even in graduate and professional training programs, suggesting an opportunity for explicit and direct information and guidance in organizational and study management skills for the particular course content from academic support personnel as well sometimes the course faculty. Furthermore, in the realm of personal differences, ethnicity does not offer strong explanation or predictive power related to students’ achievement goals and learning strategies. The outcomes probably indicate more within group than between group difference with the implication that individual student background, education, and personality are more likely to guide academic intervention than any outcome association based on ethnicity alone.

Performance achievement goals are associated with Phase 1 GPA (P1GPA) in medical school. When this attention to performance includes the avoidance dimension of valence, this anticipatory fear of failure is likely to manifest as lower GPA outcomes. Similarly, students with an approach valence dimension toward performance assessment are likely to manifest higher GPA outcomes. Finally, the ability of medical students to manage their study effort and organize their study is also associated with graded performance.

Even though GPA is associated with performance achievement goals, GPA is not necessarily an indicator of depth of learning, a relationship which also depends on instructional and assessment methods. The implication here is that students who concentrate on raising grades will tend to earn higher grades, and students who are fearful of not earning adequate grades do compromise their ability to succeed as measured by grades. The ability to manage study effort and organize study time is also an important metacognitive skill which may indicate a basic and strategic orientation to learning.
Implications for Students

Medical students are expected to show some consistency in terms of academic background, cognitive ability, goals and motivation to practice medicine, characteristics which often manifest as a strong willingness to adapt to the learning environment. Generally the medical student population can be seen as a group of well prepared, highly motivated, often self directed and adaptable students, who are alert to the requirements of the courses they are taking. This is not the case with all students, however, as some students have great difficulty adjusting to the particular demands of a contemporary medical school learning environment. Reasons include weaknesses in prior knowledge, unclear motivation to study medicine, limited self regulation skills or limited experience with self directed approaches to learning and possibly limited learning flexibility and adaptability due to low self efficacy for studying medicine.

Student ethnicity is an area of concern to educators because of the historical and reported connection of ethnicity and academic performance; a connection which indicates a higher potential for academic risk for underrepresented minority (African American, Hispanic, and Native American) students. Outcomes here do not show compromised learning behavior as a function of ethnicity. Ethnicity has been considered one of several indicators of potential for academic difficulty (due to history of prejudice, racism, and inadequate schools, for examples). Implications are that with medical students this indicator alone holds less salience than other factors which are directly related to personal educational background and personal motivation. More indicative of educational disadvantage are the personal characteristics of limited pre-medical educational opportunity, or limited exposure to the social and cultural practices common to university life and medical training and practice.
Further, in this study, there was a difference in numbers of students representing the different ethnic groups, especially disparate between the Anglo and African American student groups.

Mastery achievement goals are associated with learning self regulation, in contrast to performance-avoidance goals which do not have this association and are associated with compromised achievement outcomes (McGregor & Elliot, 2002). Self regulation includes regulation of cognition and regulation of learning environment, as well as regulation of emotional and motivational aspects of learning. Specifically, mastery-approach achievement goals are associated with the metacognitive skills which allow learners to assess their learning quality, to decide what to study, when enough information has been gathered, and the judgment to choose among conflicting information claims when encountered. The novice student is therefore expected through self directed learning to create an appropriate foundation of knowledge, and have the judgment to know if their developing level of knowledge is appropriate to the learning tasks of the course. This reliance on novice self-assessment can be exhilarating for high functioning and mature students, but can also create an unstable and non-uniform body of knowledge for individual students, young students, and potentially throughout a class.

If medical educators and admissions committees were consciously selecting for students with appropriately adaptable learning characteristics, they would seek out students who are: 1) self regulated and self directed; 2) hold learning goals which lead to deep learning strategy use; 3) are adaptable; 4) have the intellectual capacity and pre-medical knowledge to successfully complete the course work; 5) have the ability to ask for help when needed; 6) have good self assessment skills; and 7) have a professional attitude toward their training. Unfortunately this use of educational terminology is not currently widespread in
medical education and medical school admissions selection literature, so these are not usually the characteristics directly sought out by admissions committees in applicants, nor are they directly and explicitly taught to pre-medical students as optimal learning skills to develop before medical school. A related issue is the limited number of well documented instruments with which to measure these qualities in medical school applicants, meaning that any explicit selection for these learning characteristics and qualities would now be largely subjective and deductive. In any case, some advocate for considering applicants holistically in determining their appropriateness for medicine, and encouraging applicants with a knowledge base and interest in both the natural and social sciences (Sales & Schlaff, 2010).

It seems likely that the learning environment of any particular medical curriculum will challenge or override some students‘ inclinations toward learning in their preferred way. Several of these preference differences can manifest together in the PBL or TBL small group learning environment. Some students may find the personal exposure and pacing intimidating, or a cause for discomfort with group work itself. Other students may feel a misalignment with a tutorial group’s work due to differences in achievement goals held by group members, a difference which might be exacerbated by age differences. That is, students in the group holding mastery achievement goals may clash with students in the group holding performance achievement goals. For example, as the PBL group works methodically through a clinical case students with mastery goals will be more likely to address learning issues in depth and attempt to connect the new material to what is already known. In contrast, performance goals would drive students to move more quickly to “answer” the learning issues and move along with the case. The different goals for learning in the group may cause frustration from moving too fast and too superficially through the
material for some students while at the same time seeming to move too slowly and methodically for other students. Differences in quality of prior knowledge might be more easily addressed in tutorial groups than contrasting differences in achievement goals and the learning strategies held by different students in the group.

Assisting students to understand how the particular demands of the curriculum impact their study methods is important. This is complicated by the fact that there appears to be a two-tiered learning process in medical school, one for performance exams and another for establishing the deep learning and knowledge awareness exemplified by clinical reasoning and practice. Deep learning strategies connect to a student’s ability to maintain self-regulation and efficacy for learning medicine, very important for students who hold relatively fragile efficacy beliefs or are recovering self-efficacy and self-esteem following an academic or personal setback. Helping students to bridge this chasm of environmental demands and optimal personal learning goals may offer a real solution for students at risk for or experiencing academic difficulty. In addition to specifically measuring for learning goals and strategy use, a student’s beliefs about learning can be deduced from discussions about study methods which ask students to report on and describe what they actually do when studying, and to what they attribute their performance. Flexibility in learning strategy is not necessarily automatic, however, and certainly self-assessment in terms of learning processes is not automatic, so that bringing awareness to learning processes is critical for developing an ability to adapt productively to a learning environment.

This guided self-assessment of learning processes often allows for the emergence and identification of affective barriers which interfere with successful learning. Focusing on students’ affective barriers and helping them strengthen their attributional thoughts about
medicine are likely to support students in developing mastery approach goals and actually using the associated deep learning strategies. Mastery goals and deep learning strategies remain important throughout medical school because of the clear relationship between mastery goals, deep learning strategy use, self efficacy beliefs for the learning task and development of learning self regulation. Positive efficacy beliefs are also associated with lowered levels of performance anxiety, and persistence in the face of academic difficulty. Some students may struggle because they never had the efficacy beliefs to begin with to maintain mastery goals and deep learning strategies early in medical school and therefore lack the foundational knowledge to allow for needed flexibility. Achievement goals do show consistency within a learning situation (e.g. a course), except where the affective element of fear of failure becomes stronger than the efficacy for success. This may explain behaviors noted with students in academic difficulty toward inflexibility in learning strategy use, and lowered self esteem and self efficacy for studying medicine. The affective aspects of self efficacy and self regulation can be interpreted as the confluence of learning goals and strategies with learning environment.

**Implications for Medical Education**

At the curricular level, it is useful to understand the relationships among elements of the learning environment and the impact of environment on student learning, how students are motivated, how they use learning goals to monitor and adjust their learning strategies to be successful in the particular environment. Successful students become that way in part by adapting to their specific learning environment, including requirements for course assessments and types of assessments used. A question for medical educators is whether the particular learning environment encourages the kind of learning expected. If students are
adjusting their learning strategies to meet the needs of the learning environment, to what extent is this adjustment explicit, expected, and optimal? Does the learning environment promote the expected learning processes and outcome? That is, deep learning, mastery of basic science material across disciplines, clinical practice demonstrating good clinical reasoning and critical thinking skills, and integration of the disparate and dense material composing the curriculum.

Deep learning strategy use early and throughout medical training is necessary to create the cognitive architecture to support the critical thinking and clinical reasoning needed to succeed in clinical training, and in medical practice. The requirements of clinical training demand that students use the cognitive architecture developed during the first two years of basic science coursework and apply this knowledge in progressively more complex clinical cases. Novice medical students have stores of information and facts to work with, but often have yet to develop this complex understanding of the relationships among these facts and concepts. The volume of new knowledge in the first two years of basic science along with the speed of mastery often compromises this depth of understanding. Students also are not likely to have developed mastery of when and how to use pattern recognition to organize their thoughts in solving problems and reading a clinical situation. Novice medical students spend their first two years building a foundation of basic science concept knowledge, which itself builds upon knowledge acquired during undergraduate course work. With a strong basic science foundation, students can readily adapt to the new clinical learning environment in the third year where they must transfer their self regulation skills, their achievement goals and learning strategies to the learning and performance demands of clinical training. This change in learning environment can actually intensify the need for organization and clarity of
purpose, so that monitoring studying and effort management/organized studying, and other
deep learning strategy methods remain salient. Students who lack sufficient depth and
integration of their basic science knowledge will begin clinical training without a sufficient
cognitive architecture in place, and therefore will lack the interrelated knowledge schemes to
meaningfully inform their clinical encounters. Students beginning clinical training with
weak reasoning ability due to weak foundational knowledge will have difficulty emulating
the more expert physicians and residents on the wards. This inability to transfer knowledge to
the new setting may lead to serious clinical performance difficulty in the clinical training
years. Students with a broad and solid foundational knowledge will find it easier to emulate
the expert practitioners they train with as the clinical reasoning patterns are becoming more
similar, novice to expert, as the student matures in their training. That is, the novice with
mastery goals and using deep learning strategies is more likely to gain understanding at a
depth which promotes integration and development of conceptual relationship patterns. Such
a student is more likely to have developed a cognitive architecture which is complex and
sophisticated. On the other hand, the student with predominately performance goals or
mastery-avoidance goals and using surface learning strategies is less likely to have developed
a sophisticated cognitive architecture, and therefore when asked to apply this knowledge in a
clinical setting, doesn’t have the schemes in place from which they can draw practical
knowledge.

As mastery-approach achievement goals are clearly connected with deep learning
strategies, as well as self regulation skills development, and the exact skills valued for
medical students and clinical practitioners, it is reasonable to expect the curriculum to
directly support this kind of continual development. If deep learning is emphasized in the
first two years, with environmental supports in place so that students can learn in an atmosphere that encourages schema development, then deep learning in the clinical years will be a continuation of this quality of learning.

Many innovations in medical education have been implemented specifically to encourage student independent learning, self reflection and self direction in learning. Innovations such as PBL, TBL, and the CP models occurring in small interactive student groups are examples. In fact, well constructed PBL tutorial case work may offer the kind of learning environment within which students could move deeply into the medical science learning issues in progressively more depth and detail, as well as providing for development of self direction in learning efforts. The optimal combination of instructor guidance and student self direction varies in these models, but have shown demonstrated success using some variation of guided structure.

These curricular models are constructed to invite the kind of reflective, deep learning that is considered optimal in medical school and elsewhere. However, the whole of the learning environment may actually create barriers to this ideal in the form of time constraints, overly full curriculum components, assessments which select for surface learning strategies, and school wide competitive pressures for limited resources. This situation could then manifest as a clash between curriculum goals and environmental realities. The clash would be felt more deeply by some students than others, particularly those at academic risk, and some students may also find themselves in conflict with other students’ achievement goals, as well as the whole learning environment. The argument here is for a holistic view of the curriculum as it is experienced by students as a full learning environment. The challenge for medical educators remains that of providing a learning environment conducive to optimal
learning for all students, and which considers the mechanics of learning from student perspectives.

**Implications for Theory**

It is noteworthy that achievement goals were identified in the medical student sample, showing measurable differences on variables of age at matriculation, ethnicity, as well as differences based on year in medical school. As anticipated by Achievement Goal Theory, mastery-approach achievement goals predicted engagement in deep learning strategies, and mastery-avoidance achievement goals predicted engagement in surface level learning strategies with this medical student sample. Similarly, as predicted by theory, performance goals were associated most closely with medical school GPA, in both the approach and avoidance dimensions. The self-directed nature of medical education coupled with the exceptional amount of information to master makes it necessary for students to continually make judgments and choices in terms of what to study, how to study, and at what depth to study. There must be some mechanism by which students make these choices. If achievement goals are recognizable in medical students, then the descriptions of achievement goal mechanisms should also manifest as predicted by theory. Therefore, medical students can be theorized to coordinate their learning efforts in part based on what Achievement Goal Theory describes as competence constructs, where the learner determines their own standard of performance, as absolute (based on requirements of the task), intrapersonal (based on one’s own past attainment or potential attainment), or normative (based on the performance of others) (Elliot & McGregor, 2001; Elliot, 1999). This personal standard of performance, including the valence, or attractiveness of the learning task, can then be interpreted as the avenue by which students make decisions on study process. So that, achievement goals offer
a useful framework to understand how medical students orient their study. AGQ achievement goals are recognized in a medical student sample, and are recognized as arising from a personal orientation to competence (mastery/performance) and the associated valence (approach/avoidance).

Learning strategies, or approaches to learning, are understood and categorized according to how a student processes the material to be learned. Surface learning strategies involve reproductive processing of new material, and deep learning strategies involve reorganization of the to-be-learned material in a way that helps the student integrate the new material with what they already know. Similar to achievement goals, a student’s approaches to learning and strategies for learning are contextual and can be seen as the behavioral manifestation of learning goals. Therefore conceptually, approaches to learning may be more sensitive to learning environment than achievement goals because of potential for time constraints tied to curriculum scheduling and pacing, and the impact these situational constraints would have on specific learning strategies used. While achievement goals are in the realm of intent, the learning approaches and strategies employed are associated with attention to instructional methods, assessments, and curriculum specifics. In order to successfully adapt to the learning environment, students must use their metacognitive skills contextually for each course and learning task, assignment, and assessment (Ross, et al, 2006; Reid, et al, 2005; Entwistle & McCune, 2004). Certainly, students who can adapt their learning approaches and strategies to the requirements of the course and testing modalities have a greater chance of academic success, as performance has been shown to be mediated by the study strategies used (Ross, et al, 2006).
This study attempted to discover the relationships between subscales of the achievement goals and approaches to learning strategies measures for medical students. Examination of these relationships in this context is itself a new configuration of inquiry. As shown, medical students are recognized to hold achievement goals, and these goals correspond with approaches to learning as predicted. However, aside from the few statistically significant findings, the relationships among variables were modest and outcomes for the three different years of medical training were largely similar. Although the constructs under consideration were identified with this population, the few significant findings suggest that the medical student population is unique and these particular constructs may not match completely with this level of education. Apparently the selection process for medical school is thorough enough as to make these constructs less meaningful as an explanation for learning process. Although these measures pick up real processes, they may lose discrimination when used in a graduate level learning environment.

**Study Limitations**

The use of self-report questionnaires for collecting data on learning goals, intent for learning, evidence of knowledge monitoring, and the strategies used for these processes has evolved over time (Richardson, 2004). The measures have to rely on a student’s awareness of the way they study and the strategies they use (Mattick, et al 2004). Many students have a difficult time analyzing their own cognitive processes, and without specific training find it difficult to describe the way they think and their beliefs about acquiring, storing and using knowledge. Self-reports are also easily interpreted by many students which introduces the potential for test bias. The problem of self awareness may also be gender related (Byrne, Flood & Willis, 2002). The self report questionnaire format was considered a good source of
data collection for this study given the education level of the student population and an expected related level of self assessment skills, as well as the efficiency of data collection for over 200 participants.

This study used a cross-sectional design to compare three classes of students in different sequential stages of the medical curriculum, to answer a developmental question. That is, do students differ in their responses to the Questionnaire subscales as a function of their year in medical school? The intent was to ascertain change in learning habits that could be attributed to development, progressing or growth connected to level of training in the profession. Learning environment however has been seen as a central factor in medical training, indicating that any change or progression in learning habits while in medical school is more likely attributable to growth and adjustment as a medical student in the particular medical curriculum rather than growth toward expert professional practice as a physician. A progression from novice toward expert levels of thinking, reasoning and problem solving can be understood as both an academic and professional development issue. The measures used in this study, the ALSI and AGQ are not specifically designed to measure this kind of development, instead they are designed to reveal a “snapshot” of current self assessment and self reflection. Possibly following individual students through their training years would reveal different outcomes relative to changes in achievement goals and approaches to learning strategies.

Finally, given the importance of self regulation and metacognitive skills in learning, especially in the medical school environment, it is an acknowledged loss of information that the MAI proved unusable in this study.
Implications of This Study for Professional Practice

The field of medical education has been shown to change over time in part due to emergence of knowledge about learning processes as demonstrated by the research of educational and cognitive psychologists. Medical educators have increasingly relied on this knowledge to inform curriculum development and evaluation. Components of educational and cognitive science which impact the curriculum building process include the postulates that: self regulation and metacognition are vital components to all learning, self efficacy for learning is contextual and the foundation for developing self regulation skills, learning is contextual, novices and experts operate in different ways, and that development of self regulation and metacognition skills may not be automatic and therefore must be directly taught in the context of a particular course. Furthermore, it is difficult for novices to gauge what they know and do not know in order to fill in their knowledge gaps, and a completely self directed learning environment can allow for uneven foundational knowledge development within a learning cohort.

Based on this study’s outcomes, specific recommendations can be offered for medical educators:

- Consider the whole learning environment from the perspective of students. Look at the real outcomes as much as the hoped for outcomes of curriculum design, assessment, and evaluation. What does the curriculum structure demand of students‘ approaches to learning, and is this the desired outcome?

- Teach and assess learning in formats that encourage development of cognitive architecture throughout the four years of medical training. Refer often to this
developing relational and conceptual network of interrelated facts and concepts as a foundation for critical thinking and clinical reasoning.

- Be cognizant of the different learning orientations related to age at matriculation, and capitalize on the achievement goals and approaches to learning strategies of the older matriculating students to guide and lead the kind of learning environment desired for the whole cohort.

- Base individualized academic interventions on students reported achievement goals for learning and learning strategies and approaches to learning, with the idea of guiding goals and strategies to best fit with the particular learning environment.

The different curricular models of medical education described previously show how educators have struggled with these issues and tried to adjust curricula to specifically encourage deep learning and thorough processing of new information. Despite generations of curricular reform, a tension remains with maintaining a balance between material to be learned and the optimal environment in which it is taught. It remains challenging to build a curriculum which addresses the learning needs of all of the students enrolled, while adequately covering the constantly expanding breadth of basic science and medical knowledge. Conceivably, attending to students‘ goals and approaches for processing new information holds a key to a broader understanding of learning in the medical school context and answers for medical educators interested in curriculum development.
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Appendices

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Appendix B: Factor Analysis ............................................................................................... 128
Appendix A: Medical Student Learning Questionnaire

Please complete the following questions about your CURRENT block or rotation by circling the answer which most describes you.

For this first set of questions, please circle the number that corresponds to the extent to which each item is true of you on a 1-7 scale (1=not at all true of me, 7=very true of me).

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<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<tr>
<td>It is important for me to do better than other students.</td>
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<tr>
<td>My goal in this class is to get a better grade than most of the other students.</td>
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<td>I worry that I may not learn all that I possibly could in this class.</td>
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<td>Sometimes I’m afraid that I may not understand the content of this class as thoroughly as I’d like.</td>
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<td>I am often concerned that I may not learn all that there is to learn in this class.</td>
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<td>My goal in this class is to avoid performing poorly.</td>
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<td>My fear of performing poorly in this class is often what motivates me.</td>
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For the next set of questions, please circle the best answer for you—if the statement is true of you, circle the TRUE response, if the statement is not true of you, circle the FALSE response.

<table>
<thead>
<tr>
<th>Statement</th>
<th>TRUE</th>
<th>FALSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I ask myself periodically if I am meeting my learning goals.</td>
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<td>I consider several alternatives to a problem before I answer.</td>
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<tr>
<td>I try to use strategies that have worked in the past.</td>
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<tr>
<td>I pace myself while learning in order to have enough time.</td>
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</tbody>
</table>
5. I understand my intellectual strengths and weaknesses.  TRUE  FALSE
6. I think about what I really need to learn before I begin a task.  TRUE  FALSE
7. I know how well I did once I finish a test.  TRUE  FALSE
8. I set specific goals before I begin a learning task.  TRUE  FALSE
9. I know what kind of information is most important to learn.  TRUE  FALSE
10. I ask myself if I have considered all options when solving a problem.  TRUE  FALSE

11. I am good at organizing information.  TRUE  FALSE
12. I have a specific purpose for each strategy I use.  TRUE  FALSE
13. I learn best when I know something about the topic.  TRUE  FALSE
14. I know what the teacher expects me to learn.  TRUE  FALSE
15. I am good at remembering information.  TRUE  FALSE
16. I use different learning strategies depending on the situation.  TRUE  FALSE

17. I ask myself if there was an easier way to do things after I finish a learning task.  TRUE  FALSE
18. I have control over how well I learn.  TRUE  FALSE

19. I periodically review to help me understand important relationships.  TRUE  FALSE
20. I ask myself questions about the material before I begin.  TRUE  FALSE
21. I think of several ways to solve a problem and choose the best one.  TRUE  FALSE
22. I summarize what I’ve learned after I finish.  TRUE  FALSE
23. I can motivate myself to learn when I need to.  TRUE  FALSE
24. I am aware of what strategies I use when I study.  TRUE  FALSE

25. I find myself analyzing the usefulness of strategies while I study.  TRUE  FALSE
26. I use my intellectual strengths to compensate for my weaknesses.  TRUE  FALSE
27. I am a good judge of how well I understand something.  TRUE  FALSE
28. I find myself using helpful learning strategies automatically.  TRUE  FALSE
29. I find myself pausing regularly to check my comprehension.  TRUE  FALSE
30. I know when each strategy I use will be most effective.  TRUE  FALSE

31. I ask myself how well I accomplished my goals once I’m finished.  TRUE  FALSE
32. I ask myself if I have considered all options after I solve a problem.  TRUE  FALSE
33. I use the organizational structure of the text to help me learn.  TRUE  FALSE
34. I read instructions carefully before I begin a task.  TRUE  FALSE
35. I organize my time to best accomplish my goals. TRUE FALSE
36. I learn more when I am interested in the topic. TRUE FALSE
37. I ask myself questions about how well I am doing while I am learning something new. TRUE FALSE
38. I ask myself if I learned as much as I could have once I finish a task. TRUE FALSE

For the last set of questions, please indicate the extent to which each item is true of you on a 1-5 scale (1=not at all true of me, 5=very true of me).

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<th>Item</th>
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<th>Very True</th>
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<tr>
<td>2. I’ve been over the work I’ve done to check my reasoning and see that it makes sense.</td>
<td>1 2 3 4 5</td>
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<tr>
<td>3. I have usually set out to understand for myself the meaning of what we had to learn.</td>
<td>1 2 3 4 5</td>
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<tr>
<td>4. I have generally put a lot of effort into my studying.</td>
<td>1 2 3 4 5</td>
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<td>5. Much of what I’ve learned seems no more than lots of unrelated bits and pieces in my mind.</td>
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<td>6. In making sense of new ideas, I have often related them to practical or real life contexts.</td>
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<td>7. On the whole, I’ve been quite systematic and organized in my studying.</td>
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<td>8. Ideas I’ve come across in my academic reading often set me off on long chains of thought.</td>
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<td>9. I’ve looked at evidence carefully to reach my own conclusion about what I’m studying.</td>
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<td>10. When I’ve been communicating ideas, I’ve thought over how well I’ve got my points across.</td>
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<td>11. I’ve organized my study time carefully to make the best use of it.</td>
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12. It has been important for me to follow the argument, or to see the reasons behind things.

13. I’ve tended to take what we’ve been taught at face value without questioning it much.

14. I’ve tried to find better ways of tracking down relevant information in this subject.

15. Concentration has not usually been a problem for me, unless I’ve been really tired.

16. In reading for this course unit, I’ve tried to find out for myself exactly what the author means.

17. I’ve just been going through the motions of studying without seeing where I’m going.

18. If I’ve not understood things well enough when studying I’ve tried a different approach.

When did you decide to apply to medical school—What year in school were you?

What general comments do you have about learning in medical school? (Please turn page over for more room if needed).
Appendix B: Factor Analysis Details

Table B1

*Factor Loadings for Exploratory Factor Analysis With Varimax Rotation of the Achievement Goals Questionnaire scales.*

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Note: Factor loadings > .40 are bolded. MApp= Mastery-approach; MAv=Mastery-avoidance; Papp=Performance-approach; PAv=Performance-avoidance.

Table B2

*Factor Loadings for Exploratory Factor Analysis With Varimax Rotation of the Metacognitive Awareness Inventory scales.*

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*Factor Loadings for Exploratory Factor Analysis With Varimax Rotation of the Metacognitive Awareness Inventory scales.*

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**Factor Loadings for Exploratory Factor Analysis With Varimax Rotation of the Metacognitive Awareness Inventory scales.**

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Note: Factor loadings > .40 are bolded.

### Table B3

**Factor Loadings for Exploratory Factor Analysis With Varimax Rotation of Approaches to Learning and Studying Inventory Scales.**

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Table B3 (continued)

*Factor Loadings for Exploratory Factor Analysis With Varimax Rotation of Approaches to Learning and Studying Inventory Scales.*

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<th>MS</th>
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Note: Factor loadings > .40 are bolded. DA=Deep Approach; SA=Surface Approach; MS=Monitoring Studying; EMOS=Effort Management/Organized Studying.