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Learning Styles, Critical Thinking Aptitudes, and Immersion Learning in Physician Assistant Students

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Dedication

I dedicate this work to my husband, Stanley Lowy. I can never thank you enough.

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Abstract

The changes in healthcare delivery systems and the global burden of disease along with the overwhelming corpus of new knowledge call for a re-evaluation of the educational process of health profession programs. The focus on how best to optimize the learning process necessitates an acknowledgement of the roles of learning styles and critical thinking aptitudes. It also requires attention to the learning experiences and how these, in turn, affect development of both the styles and aptitudes. A sample of 137 Physician Assistant students was recruited to complete a learning style inventory, the Gregorc Style Delineator, and a critical thinking aptitude test, the Health Science Reasoning Test. Participants were then divided into two subgroups, identified as 'preclinical PA students' and 'clinical PA students' and the results obtained from both instruments were compared to explore for possible associations between immersion clinical experiences and learning style preferences and critical thinking aptitudes. The PA students were preferentially concrete sequential learners with moderate to strong critical thinking aptitudes. There were no significant differences between preclinical and clinical PA students with respect to learning styles or overall critical thinking aptitudes. Significant differences (P=.002) with improvement in scores, was noted for only one parameter of critical thinking, identified by the Health Science Reasoning Test as "inference". While immersion learning did not appear to impact learning style preferences or overall critical thinking aptitudes, it is important to note the improvement in 'inference; a skill critical for the medical decision making process required of PA students in their preparation for future practice.

Chapter I.

Introduction

Background of the Problem

Educators of the health professions, committed to preparing future healthcare providers, are confronted with the challenge of transmitting an ever expanding body of knowledge. As the world of medical care changes (Eyal & Cohen, 2006) the corpus of knowledge basic to medicine continues to grow exponentially (Armstrong & Parsa-Parisi, 2005). This overwhelming array of new information, necessary for effective patient treatment and care(Keahey & Goldgar, 2004)threatens the ability of curriculum planners to remain current, taxes the ability of students to absorb the required material, and thus may render graduates unprepared for today's clinical practice (Eyal & Cohen, 2006). Medical educators are placed in the midst of a major transformation in medical education as they try to reassess their teaching practices and develop new approaches to optimize student learning (Torre, Daley, Sebastian, & Elnicki, 2006).

The changes in healthcare delivery systems along with the global burden of disease necessitate a re-evaluation of the educational process (Armstrong & Parsa-Parisi, 2005). The heavy workload and excessive amount of course material are aspects of medical curriculums that may be encouraging disadvantageous learning techniques, hindering students' abilities to grasp important principles (Eyal& Cohen, 2006). Therefore, educators, seeking to effectively prepare qualified health professionals, must understand the differences in how their students learn (Robotham, 2007)acknowledge their critical thinking aptitudes (Ferretti, Krueger, Gabel, & Curry, 2007)and then consider how best to optimize the learning process. Unfortunately, educators often overlook the impact of the learning process and teach as if differences between students do not exist (Paul, Bojanczyk, & Lanphear, 1994). Students, in response, often times feel dissatisfied with the learning process and often perceive instruction materials as lacking relevance (Eyal & Cohen, 2006). Consequently, performance often varies, from student to student and educators are left puzzled by these differences. Refusal to acknowledge differences in learning or critical thinking aptitudes does not allow for adjustments to the learning process. On the other hand, acknowledging the differences among students and the impact of these differences on the learning process can promote deeper learning and improve the acquisition of knowledge (Johnson & Mighten, 2005) critical to the understanding and practice of medicine.

Need for the Study

In recent years, research studies have explored the inconsistencies in the learning process. One proposed explanation for the inconsistencies is that students rely on individual preferences in learning styles and that these preferences account for the uneven learning of the same material (Lujan & DiCarlo, 2005). The literature offers numerous theories on learning styles and various instruments to measure these styles in an attempt to profile students with respect to learning preferences. Multiple paradigms of learning styles exist with no widespread acceptance for any one theory (Robotham, 2007), but the common denominator among the theories is the conclusion that learning preferences impact the learning process and that, therefore, it is imperative that educators acknowledge these learning preferences.

Knowing how accepted students prefer to acquire and process information is important for educators (Olson, 2000). A foregone conclusion, supported by the National Research Council, is that teaching focused on content alone is not likely to lead to proficiency (Willingham, 2007)and is a relatively ineffective pedagogical tool for promoting conceptual understanding (Knight & Wood, 2005). The notion that teaching simply refers to the transference of knowledge dictated by the discipline is no longer (Hardigan & Cohen, 2003) and today's environment makes that educational approach obsolete (Beers, 2005). In fact, it has been argued that lectures as a teaching method in medicine may no longer be appropriate (Dehn, 2004). Therefore, identifying the learning characteristics of students is viewed as an indispensible tool for improving learning outcomes (Vitsupakorn, 2004). For some educators identifying how students learn helps in the construction of curriculums that are better aligned with students' learning needs (McDonnough & Ostserbrink, 2005). Educators then can use this information to improve instructional design and modify instruction (Carrier, Newell, & Lange, 1982). Yet other educators do not embrace the need or relevance of matching teaching methods to learning preferences to improve learning (Murphy, Gray, Straja, & Bogert, 2004). Rather, they believe that depending on the material to be learned, different learning styles may be more effective (Robotham, 2007). For these educators, their research is focused on ascertaining if a correlation exists between the different learning styles and measurable outcomes such as performance in clinical practice (Carrier, Newell, & Lange, 1982). This is particularly valuable in medical education, given the phenomenal growth and expansion of medical knowledge and the emphasis on the design and development of learning experiences that will best prepare future healthcare practitioners (McManus, Richards, Winder, & Sprosten, 1996, Morgan & Cleave-Hogg, 2002). Medical educators can no longer view their students simply as repositories of information (Scott, Lloyd, & Kelly, 2005). They must consider how the information they are transmitting is best absorbed, how to encourage active learning (Lesgold, 2001)how to best involve students in the learning process.

The mission of health profession programs is to prepare future qualified professionals, who will possess the requisite knowledge and skills for future practice in their respective fields (Li, Chen, & Tsai, 2007). In order to achieve that mission programs have set forth two important goals. The first is the effective transmission of medical knowledge specific to the respective fields and the second is the fostering of the clinical thought processes critical to professional practice. To meet these goals, educational programs must attempt to encompass an ever-expanding body of knowledge reflective of current health priorities; global health concerns, urgent health priorities, emergent threats and knowledge derived from new research. (See Figure 1: Effective Medical Education) This process must also provide for the integration of academic and clinical learning opportunities. Ultimately the purpose of the process is to develop critical thinkers, students with the clinical thought processes necessary for practice in their respective fields (See Figure 2-Developing Clinical Thought Processes). But in order for these goals to be achieved it is important to identify characteristics of students that may impact the learning process, such as students' learning styles and critical thinking aptitudes.

In addition, we should consider how the current learning process may be impacting, facilitating or impeding, the development of those same characteristics. Since the recruitment of sufficient quality clinical sites is often a challenge for programs, the value of immersion learning during clinical experiences has been raised. The intent of this study is to identify the learning style preferences and critical thinking aptitudes of healthcare students, specifically physician assistant students, and to explore the impact of immersion in clinical experiences on the learning process looking for changes in either learning style preferences or critical thinking aptitudes.

The education of future physician assistants has always been an important endeavor of the Physician Assistant (PA) profession (Rahr, Schmalz, Blessing, & Allen, 1991), but the research regarding the PA educational process is limited. Physician assistant education is a complex combination of basic science, clinical academic coursework, and practical clinical experience (Cody, Adamson, Parker, & Brakhage, 2004). Throughout the process, physician assistant educators strive to prepare their students to competently practice medicine (Keahey & Goldgar, 2004). One of the challenges in teaching PA students is the sheer volume of material that needs to be covered within a limited time frame (Wing & Crouse, 1998). As the knowledge base for the profession rapidly changes and expands, greater emphasis must be placed on finding ways to optimize the learning process. An understanding of PA students' learning style preferences and critical thinking aptitudes as well as an assessment of the learning process can be beneficial to educators. This knowledge could serve to help enhance the incorporation of new information and skills (Rahr, Schmalz, Blessing, & Allen, 1991)and could facilitate the development of the skills and aptitudes required for future practice. It could also help educators to select optimal learning experiences(Ives & Howell, 2011) that encourage active learning (Dowell, Crampton, & Parkin, 2001)thereby preparing physician assistant students to become competent collaborative practitioners (D'Amour & Oandasan, 2005)capable of managing the medical situations they will encounter in clinical practice(Morgan & Cleave-Hogg, 2002).

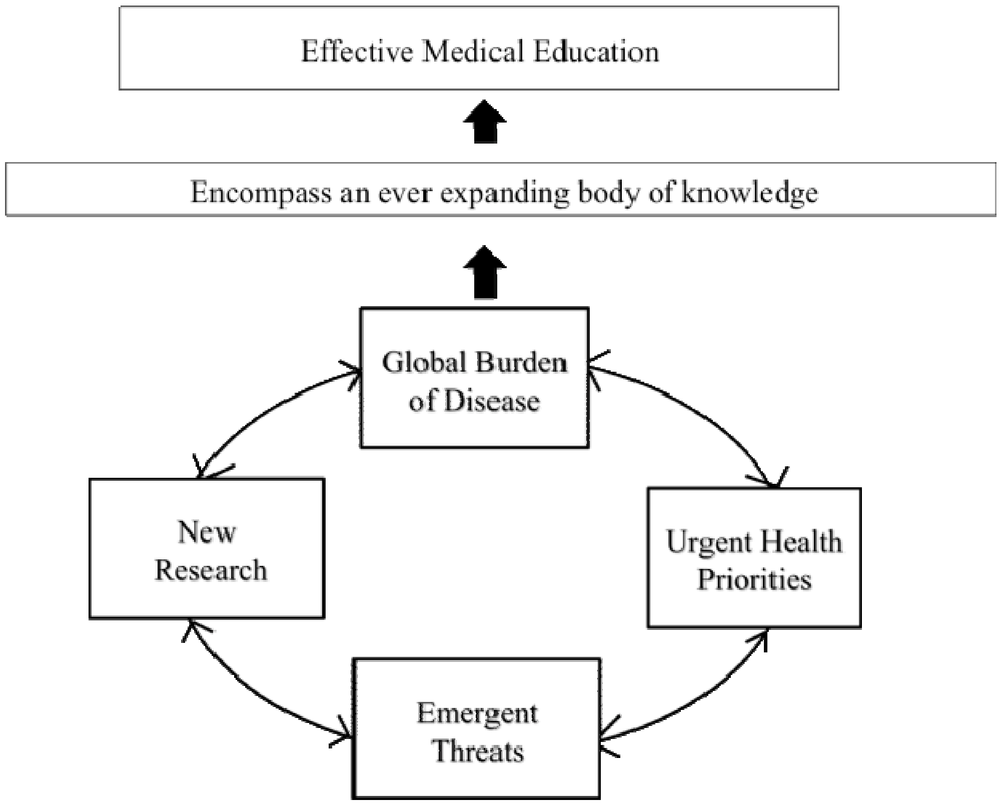

FIGURE 1. Effective Medical Education

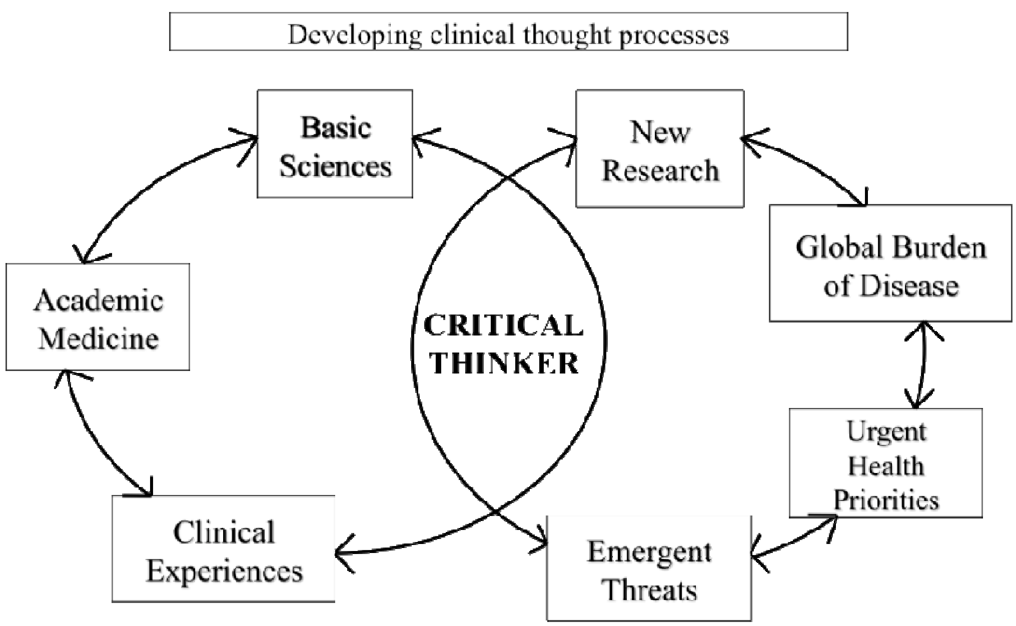

FIGURE 2. Developing Clinical Thought Processes

Purpose of the Study

The purpose of the study is to assess the learning style preferences and critical thinking aptitudes of physician assistant (PA) students and to determine if immersion in clinical experiences is associated with changes in either learning style preferences or critical thinking aptitudes.

Research Questions

Four research questions have been identified.

(1) Do PA students demonstrate a preference for a specific learning style, as measured by the Gregorc Style Delineator?

(2) What are the critical thinking aptitudes of PA students, as measured by the Health Science Reasoning Test?

(3) Are there differences in PA students' learning style preferences when comparing pre-clinical to clinical students?

(4) Are there differences in PA students' critical thinking aptitudes when comparing pre-clinical to clinical students?

Research Hypothesis

In response to the four research questions posed, four hypotheses were developed. The research hypotheses postulate the following:

The first hypothesis postulates: (H1) PA students, as measured by the Gregorc Style Delineator, demonstrate a preference for the concrete sequential (CS) learning style.

The second hypothesis postulates: (H2) PA students, as measured by the Health Science Reasoning Test, demonstrate ‘moderate’ to ‘strong’ critical thinking aptitudes.

The third hypothesis postulates: (H3) Learning style preferences of clinical PA students do no differ from those of pre-clinical PA students.

The fourth hypothesis postulates: (H4) Critical thinking aptitudes of clinical PA students are stronger than those of pre-clinical PA students.

Chapter II.

Literature Review

Introduction

"*In considering learning and how to improve student learning, one needs to understand the ways in which an individual learns*" (Robotham, 2007).

The learning process has been studied from the points of view of the behaviorist, social learning, humanist, cognitive, and constructivist theories (Torre, Daley, Sebastian, & Elnicki, 2006). These theories have served as foundations for the development of various learning style models that were then utilized in the development of learning style inventories. (See Figure 3: Learning Theories to Learning Models). Each of the theoretical viewpoints plays an important role in the education of health professions. It is important to recognize the different views of the learning process and to determine how these findings can be utilized to further enhance the learning process of health profession students.

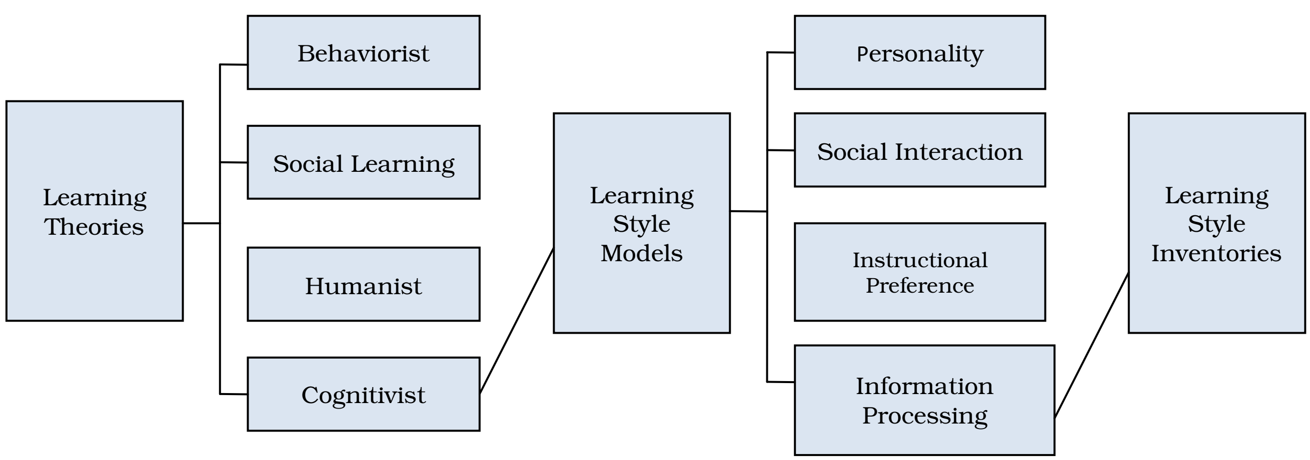

FIGURE 3. Learning Theories to Learning Models

Learning Theories

The learning process has been described differently based on the theory of choice (Torre, Daley, Sebastian, & Elnicki, 2006). The four major categories of learning theories are the behaviorist, social learning, humanist and cognitivist theories. Each of these theories describes the learning process from a different perspective thereby seeking different outcomes (See Figure 4-Overview of Major Learning Theories). The behaviorist theory emphasizes the importance of teacher-led learning experiences that result in a change in the behavior of the learner (Torre, Daley, Sebastian, & Elnicki, 2006).According to this theory, learning relies on educators demonstrating the requisite steps in an orderly progression. In this mode, the instructor illustrates the desired skill and the student repeats the behavior. For the health professions, this is often the preferred mode of instruction in the development of clinical skills. Therefore, according to the behaviorist theory, the desired outcome of education is behavioral modification.

The theory of social learning similarly emphasizes the role of modeling and behavioral rehearsal. It assumes that learning is embedded in observation and therefore occurs in a social context. (Torre, Daley, Sebastian, & Elnicki, 2006). It differs from the behaviorist orientation in that it also embodies a cognitive component that is represented by the idea that learning may occur by observation alone.(Torre, Daley, Sebastian, & Elnicki, 2006). The social learning orientation is often used in collaborative learning and in situations where a desired outcome is modeled by a role model/teacher and then repeated by the learner. As an example, it is through social learning that students absorb the professional decorum expected of health care providers as they interact with clinical advisors and preceptors.

The humanist theory views learning as a process of self-actualization and self-fulfillment. It is the learner's motivation to be all that he can be which drives the humanist orientation (Torre, Daley, Sebastian, & Elnicki, 2006). The humanist orientation leads to autonomous and self-directed learning. This approach is most often utilized in technology-based distance learning, and problem-based learning scenarios.

Conversely, the cognitive theory focuses on the thought processes of the individual learner, rather than on the external environment. Learners are encouraged to learn by reflecting upon new concepts and then relating those concepts to previously acquired knowledge (Torre, Daley, Sebastian, & Elnicki, 2006). Concept maps are often used to help the learner identify key issues and relationships. This method fosters critical thinking, an integral skill for future effective and quality clinical practice, and a skill encouraged by cognitive teachers (Beers, 2005).

The constructivist approach, a more recent theory of learning, asserts that a student learns by integrating the learning experience into previously acquired knowledge and beliefs (Torre, Daley, Sebastian, & Elnicki, 2006). In other words, the learner develops meaning from his learning experiences through critical reflection on his own assumptions. This internal process is believed to deepen understanding. In practice, the learner is encouraged to journal his learning experiences, prepare practice narratives, and develop course portfolios to deepen his own understanding. Sharing reflections during group activities allows these assumptions to be dissected and critiqued by peers, helping uncover new perspectives that augment each student's perceptiveness.

The desired learning outcome is the deciding factor in determining the learning theory to be used. If the desired outcome is that the student acquires new skills, the behaviorist approach would be most suitable. If the learners are to assume personal responsibility for their own ongoing education, then the humanistic approach triumphs. If the goal is for the learners to imitate improved practices, then the social learning approach may be preferred. On the other hand, if one is trying to teach critical thinking and complex problem solving skills then the cognitive approach prevails.

The cognitive theory has served as the foundation for the development of several learning style models and has initiated a growing emphasis in education on the development of critical thinking aptitudes. The belief is that cognitive learning styles influence the efficacy of the learning process. As the role of health care professionals evolves, greater emphasis will be placed on the cognitive skills of problem solving, brain-storming, and critical thinking (Huston & Huston, 1995). Educators striving to prepare their students to competently practice medicine (Keahey & Goldgar, 2004) will therefore, benefit from identifying their students' cognitive learning styles and finding ways to utilize that knowledge to help improve their students' critical thinking aptitudes. Therefore, for the purpose of this study, the cognitive learning theory was selected as the theoretical foundation upon which this study was designed.

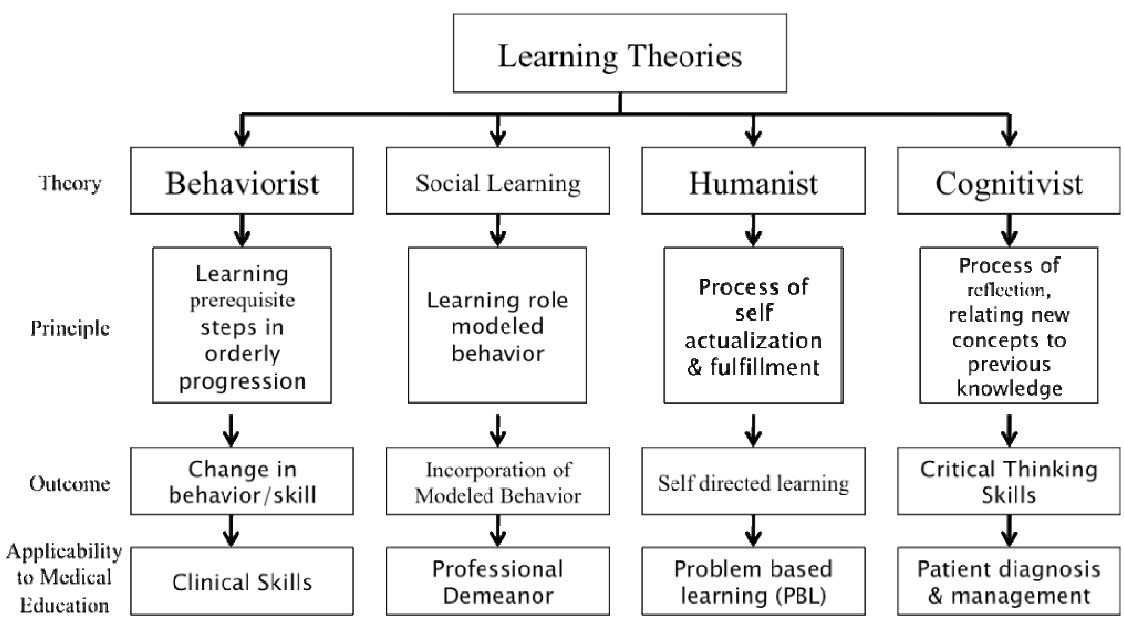

FIGURE 4. Major Learning Theories

Learning Styles

Several factors have been recognized as influencing the performance of health professions students and practitioners (Huston & Huston, 1995). A factor critical to the efficacy of health professions education is the incorporation of students' preferred methods of learning new information (Hauer, Straub, & Wolf, 2005). Research shows that students comprehend at different rates and that these rates are related to differences in learning styles (Felder, 1993). The term learning style is used to refer to individual tendencies toward particular learning approaches (Robotham, 2007). Researchers postulate that everyone develops a learning style (Murphy, Gray, Straja, & Bogert, 2004) early in life that remains constant overtime (Wells, 1990). Importantly, these differences in styles can shape how students learn (Marcy, 2001).

Learning styles have been described as the natural tendencies demonstrated by individual learners (Olson, 2000) that manifest as strengths and preferences for taking in and processing information (Felder & Spurlin, 2005). The term learning style has also been defined as the manner in which the learner most efficiently and effectively perceives, processes, stores, and recalls learned material (Hauer, Straub, & Wolf, 2005) or, stated more simply, the preferred way of acquiring information (Berlocher & Hendricson, 1985). These learning styles, or individual attributes for interacting with instructional circumstances, have been correlated to learning outcomes (Paul, Bojanczyk, & Lanphear, 1994).

Learning Style Inventories

Based on the learning theories selected, learning style models were developed. These, in turn, served as the foundation for learning style inventories. (See Figure 2: Learning Theories to Learning Models). The theoretical foundation for this study is the cognitive learning theory and the learning style model, built upon that theory, selected for this study is Information Processing.

As early as the 1970's, the literature devoted to learning styles began introducing methods for measuring learning styles (Robotham, 2007). Since then, multiple instruments have been created in an attempt to classify individual styles (McDonnough & Ostserbrink, 2005). Learning styles vary depending on the composition of a group and are different from one school to another (Dee, Nauman, Livesay, & Rice, 2002). Therefore, educators are increasingly urged to measure learning style preferences. One assumption is that if educators determine their students' learning style preferences, then they can adjust their teaching methods to improve learning outcomes (Paul, Bojanczyk, & Lanphear, 1994). Assessing learning styles enables the educator to teach in a manner more congruent with the students' needs (Robotham, 2007).Another application of learning style assessment is to help students derive insight into their own learning strengths and weaknesses (Felder & Spurlin, 2005). Students are thus encouraged to become actively involved in their education through tools that help them become better learners (Marcy, 2001). Thus, inventories that can assess student approaches to learning empower both students and faculty to improve the learning process (Olson, 2000). Several assessment tools or inventories have been developed (Dee, Nauman, Livesay, & Rice, 2002) and have been in existence for at least 20 years (Mattick, Dennis, & Bligh, 2004). The theoretical foundations for these self-report measures are the models of the learning process.

The composite of characteristic cognitive, affective, and physiologic factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment is assessed through learning style inventories (Stradley, Buckley, Kaminski, Horodyski, Fleming, & Janelle, 2003). Several models have been developed to explain the variations in learning styles and these form the theoretical foundations for their corresponding learning style inventories.

The various learning style models derived from the cognitive theory focus on distinct aspects of learning and can be differentiated into four categories: personality models, social interaction models, instructional preference models, and information-processing models (Marcy, 2001). The personality models examine individuals' personality characteristics. The corresponding personality style inventories provide insight into how reactions to learning situations will vary based on the personality styles of students (Marcy, 2001). An often cited example is the Myers-Briggs Type Indicator and the 16 personality styles identified with this inventory (Sliwa & Shade-Zeldow, 1994). Personality factors have been found to play a key role in the process of choosing one's career (Taylor, Clark, & Sinclair, 1999). In medicine, these factors are correlated with specialty choice and practice type (Sliwa & Shade-Zeldow, 1994). While it has been noted that specific personality traits are attracted to specific specialties and professions (Zeldow & Daugherty, 1991) the same cannot be said for the other learning style models. In fact, the learning styles of students have been found to vary within each major (Wolfe, Bates, Manikowske, & Amundsen, 2005) and are often evenly distributed within one group of students (Stradley, Buckley, Kaminski, Horodyski, Fleming, & Janelle, 2003).

The social interaction models focus on students' behaviors in the classroom and toward the learning process. According to these models the variations in learning are attributable to students' motivational factors, whether they are grades or interest in subject matter (Marcy, 2001). Examples of inventories are the Approaches to Learning and Studying Inventory (ALSI) and the Brigg's Questionnaire. These inventories identify students' study habits as surface, strategic, or deep. The surface approach refers to studying for the fear of failure; the strategic approach as studying to optimize success in achievement; and the deep approach studying due to an interest in maximizing understanding (Mattick, Dennis, & Bligh, 2004). A newer instrument for measuring social learning preferences is the Grasha-Riechman Student Learning Style Scales (GRSLSS), utilized to determine preferences in 6 learning style categories. It found significant differences in motivational factors between students selecting online distance learning and those opting for on-campus learning experiences (Diaz & Cartnal).

The instructional preference models describe how students prefer to acquire information (Marcy, 2001). They assess learning styles based on students' preferred sensory modalities (Lujan & DiCarlo, 2005). The VARK (visual-auditory-reading-kinesthetic) inventory is an example of an instructional preference model that differentiates students based on their preference for receiving information through the visual, auditory, reading, or kinesthetic modalities.

Finally, the information processing models reflect on the learners' internal cognitive processes. These models are based on the second and third criteria of Jung's personality typology (Jung initially proposed the three criteria of extroversion-introversion, sensing-intuition, and thinking-feeling; and a fourth criteria of thinking-feeling was later added on by Briggs-Myers). The second criterion of sensing-intuition defines the method of information perception, and the third criterion of sensing-intuition defines how information is processed. Similarly, according to the information processing models, learning is dependent on how students take in and process information. Each of the dimensions of the information processing models has two polar characteristics and the varying combinations of the characteristics result in the different learning styles. Examples of information-processing inventories include Kolb's Learning Style Inventory (LSI), Felder's Index of Learning Styles (ILS) and Gregorc Style Delineator (GSD).

The literature offers many examples of learning style inventories being utilized to determine students' learning styles as well as tests developed for the assessment of critical thinking aptitudes.

VAK/VARK Inventory.

This inventory based on the instructional preference model is a commonly used model of learning styles that categorizes students according to the neural system preferred for receiving information (Lujan & DiCarlo, 2005). According to the VAK model students are visual, auditory, or kinesthetic learners. Visual learners learn through seeing drawings, pictures, and other images. Auditory learners learn by listening to lectures and participating in discussions. Kinesthetic learners learn through physical touching and other hands-on experiences.

The VARK inventory was developed in 1987 by Neil D. Fleming in an effort to improve faculty development and to help students become better learners (Marcy, 2001). He added a fourth category to the VAK to create the Fleming VARK questionnaire (Lujan & DiCarlo, 2005). The purpose of the fourth category of reading/writing was to account for those who learn through written materials.

In a study of first year medical students at Wayne State University School of Medicine, Lujan found that only 36.1% of the students responding to the Fleming VARK questionnaire preferred to receive information via a single sensory modality (4.8% were auditory learners, 7.8% preferred learning from written materials, and 18.1% preferred kinesthetic learning). Since the overwhelming majority (63.8%) preferred multiple modes of learning, Lujan concluded that a blend of visual, auditory, reading/writing, and kinesthetic instructional techniques would most benefit the majority of medical students. The study suggested, however, that students who are strongly dependent upon only one mode of learning should be targeted with specific techniques adapted to their individual learning styles. While the above conclusions seem reasonable, the study did not actually provide any instrument by which to measure student outcomes in academic achievement or development of critical thinking aptitudes.

A study of 100 Temple University dental students (Murphy, Gray, Straja, & Bogert, 2004) also assessed student-learning preferences via Fleming's sensory modality instrument, the VARK questionnaire. The learning profiles of the dental students were compared to the significantly broader VARK public website population of 31,243 respondents. Dental student learning preferences reflected multimodal patterns (56%) comparing closely to the distribution compiled on the VARK public website (58%). Multimodal preference was described as a bimodal strength or greater with no single dominant style. However, amongst the dental students demonstrating a single dominant modality preference there was a much higher percentage of visual learners and a lower percentage of kinesthetic learners as compared to the VARK public website respondents. The differences between the two populations were not, however, significant with respect to the proportions of learners who selected aural or read/write modalities.

Among the dental students the read/write and visual modalities ranked highest at 4.1 and 4.0 mean scores per respondent respectively. The aural modality ranked next with 3.2 mean scores and the kinesthetic modality ranked last with 1.7 mean scores. The strong preferences among dental students for visual learning coupled with strong read/write preferences seems to suggest that the traditional lecture format is generally adequate if highlighted with pictures, diagrams, PowerPoint presentations, handouts, or guided notes.

Similar results were obtained with physician assistant students at Emory University. The first year PA students were invited to complete the VARK inventory (Marcy, 2001)and eighteen of the 50 first year students completed and submitted their inventory results. Amongst those, the highest distribution was the multimodal category. Seventy two percent were multimodal, 22% were in the read/write category, and 6% were kinesthetic. Mary (2001) stresses that the information derived from the VARK inventory can potentially improve the ability of faculty to reach and interact with students, but should not be used for diagnostic or predictive purposes.

Brigg's Questionnaire.

The Brigg's Questionnaire, based on the Social Interactive Model, identifies students based on study habits. Students are classified as surface, strategic, or deep learners. Surface learning is defined as rote learning, focusing on task components in isolation with little real interest in the content. Strategic learning is defined as the use of techniques that achieve the highest grades, resulting in uneven levels of understanding. Deep learning on the other hand, refers to "one which relates ideas to evidence, integrates material across courses, and identifies general principles" (McManus, Richards, Winder, & Sprosten, 1998).

The question of the correlation between learning styles and results on examinations was addressed utilizing the Briggs questionnaire (McManus, Richards, Winder, & Sprosten, 1998). Two different cohorts of British medical students were studied both at the time of application and at the end of their five-year course of study. The students' secondary school final examination grades, learning styles, actual clinical experience, and subsequent performance on final examinations were assessed in order to determine which factors correlated most closely with final examinations results. The study showed a correlation between learning styles and final examination results. As one would expect, surface learning correlated negatively with success in the final examinations, where as strategic and deep learning correlated positively with examination success. Although the correlation between study habits at the time of admission to medical school and final examinations was not significant, the study habits and learning styles during the last year of medical school were predictive of success on the final examinations.

Furthermore, there was a significant correlation between study habits and clinical experience. High surface learning scores at time of application were negatively related to clinical experience. Higher deep and strategic scores were positively related to higher levels of overall clinical experience, whether study habits were measured at the time of application or at the end of their studies.

The results of the study showed no significant correlation between the student’s clinical experience and results on the final examination. McManus (1999) concludes that the lack of correlation may reflect on the final examinations not adequately measuring the skills and knowledge gained as the result of clinical experience. Or conversely, students may not be learning sufficiently from their clinical experience. Another possibility is that the format of examinations determines what and how students choose to study and that given the format of academic examinations, some students may focus less on clinical work and more on academic learning as presented in textbooks, as to achieve highest possible test scores

McManus (1999) further utilized the Brigg’s Questionnaire to study the effect of motivating study habits on the selection of degrees and medical career preferences. Not surprising was the finding that the high surface learners were less likely to extend their program by one year to achieve an intercalated degree, or what would be referred to in the American educational system as a double major. It, therefore, appears that deep learners, reflective of the more motivated students, achieve higher academic success. What it doesn't explain is how these students achieve that success – that is, what learning style worked best for those wishing to achieve academic success.

Hemispheric Mode Indicator.

The Hemispheric Mode Indicator is an instrument that differentiates between left- brain learners, right- brain learners, and whole- brain learners (Huston & Huston, 1995). Left- brain learners are concrete thinkers, right- brain learners are symbolic thinkers, and whole- brain learners use both modes of thinking. The left hemisphere processes one stimulus at a time in a sequential manner while the right hemisphere processes a cluster of stimuli contemporaneously (Huston & Huston, 1995). Therefore, the student who relies heavily on the left side of the brain is considered a convergent thinker while the student relying on the right side- a divergent thinker.

Huston (1995) attempted to relate learning style, personality type, and performance. Learning style was measured using the Hemispheric Mode Indicator Instrument, personality type using the Meyers- Briggs Type Indicator and performance on the basis of two tasks normally expected of medical record transcriptionists.

Given the small sample size of 23, the Hemispheric Mode Indicator instrument noted that only 8 (or 35%) were assessed as left-brain learners, 5 (or 22%) were right- brain learners, and 10 (or 43%) were whole-brain learners. Personality type preference data from the Myers-Briggs instrument was limited to the perceiving category of functions, i.e., sensor and intuitive, as these are believed to be the personality types most associated with left brain-right brain thinking.

Results of the study were interesting. There was no significant correlation between hemispheric dominance and personality types, or between scores on the performance test and personality type. However, hemispheric dominance did correlate with performance. Left- brain learners scored better on both the routine and creative tasks assigned. However, when each of the groups was assessed individually, left- brain learners scored higher on the routine tasks than on the creative tasks while right- brain learners scored higher on the creative tasks than on the routine tasks. Whole- brain learners, similarly, to the right- brain learners, scored higher on the creative tasks than on routine tasks.

Huston (1995) posits that the higher overall scores of left-brain learners may indicate that both the educational system throughout the country, and the health related curricula in particular tend to favor the left-brain learner. They also posit that left-brain learners would more likely seek careers in health care precisely because it involves procedures and thought process most accommodative to their natural tendencies.

The purpose of the study was to relate a cognitive learning style, a personality style, and academic performance. Of particular importance was the finding that while academic performance did not correlate to personality styles, it did correlate to cognitive learning styles, thereby supporting the selection of a cognitive learning style inventory for studies exploring factors influencing academic outcomes.

Felder's Index of Learning Styles (FLS).

Felder (2005), defines learning style in terms of five dimensions; a preference for receiving sensory vs. intuitive information, a preference for visual vs. verbal sensory modality, a preference for inductive vs. deductive organization, a preference for active vs. reflective processing of information, and a preference for sequential vs. global progression towards understanding. He sees all these modalities as a continuum rather than an either/or dichotomy. Further, Felder believes that while these preferences may be strong, moderate, or almost non-existent, they may change with time, and may vary from one subject or learning environment to another.

The learning preferences of Tulane Biomedical Engineering students were measured using Felder's ILS (Dee, Nauman, Livesay, & Rice, 2002). It was discovered that these students preferred: receiving information visually rather than verbally, processing information actively rather than reflectively, comprehending information globally rather than sequentially, and focusing on sensory rather than intuitive information. When these students were compared with other Tulane students, the biomedical engineering students had the strongest preference for the global learning style. Although, when Tulane biomedical engineering majors were compared with other Tulane students not majoring in biomedical engineering but enrolled in the same courses, the learning preferences were quite similar. Furthermore, when these students were compared with biomedical engineering students at other universities the learning styles did not remain constant.

The study then compared student learning preferences with SAT scores and GPAs at the end of the sophomore year. Other than on the focus and recall domain, there was little correlation between learning styles and performance on the SAT. The study therefore concluded that Felder's ILS does not correlate with either intelligence or academic achievement and could not identify a "correct" learning style of "smart" students (Dee, Nauman, Livesay, & Rice, 2002).

Felder (1993), responding to a study investigating the phenomena of why some, presumably equally talented, science students eventually drop out of the sciences and pursue other fields, addresses how educators should go about making adaptations to students' learning styles.

Felder (1993), points out that sensory learners prefer facts and observations, whereas most college science courses emphasize abstract concepts, theories, and formulas. Sensors are less comfortable with symbols, whereas most science lectures and examinations are expressed in symbols such as words and formulas. Most visual learners prefer pictures, diagrams, graphs, and demonstrations, but most college science courses are taught conventionally with an overwhelming verbal emphasis. Whereas inductive learners need to process quantities of specific data working up to the formulation of general principles, most college science courses in contrast, present the principles immediately. Active learners need to try things out whereas reflectors need to think things through before trying them out. The standard college lecture format does very little to either group; giving no opportunity for active learners to engage and no time for reflective learners to stop and think. Sequential learners can absorb material piecemeal while global learners need to see how everything fits into the big picture. Incidentally, few college science courses rarely present scientific material in the broader perspective.

Furthermore, Felder (1993) posits that most educators typically teach from the perspective of their own preferred learning style, and generally tend to teach the way they themselves were taught. Hence, most college science courses heavily favor the small percentage of college students who are at once, intuitive, verbal, deductive, reflective, and sequential. Felder recognizes that it would be virtually impossible to address all learning styles simultaneously, but recommends instead that instructors try to address each learning style dimension at least some of the time. He also suggests that to do so should not require any drastic changes in teaching style or overhaul of materials. Merely prefacing theoretical material with a brief discussion regarding the kinds of problems it can be expected to solve, will concurrently help sensing, inductive, and global learners.

Balancing concrete information with conceptual information aids both sensory and intuitive learners. Providing experimental observations before presenting the general principles, and allowing students to work collaboratively to infer general principles bolsters inductive learners. As simple a technique as allowing a few minutes of class time during each class period to reflect on the information presented, perhaps assigning “one-minute papers” at the close of the lecture period aids reflective learners. Recognizing that these techniques all take time, Felder (1993),suggests more efficient strategies such as foregoing writing material on the board and instead distributing handouts, which can be quickly reviewed in class and free up time for techniques that embrace other learning styles. Finally, educators should inquire about their students’ learning styles, assuring struggling learners that they are in no way learning impaired, but simply learn differently.

Kolb’s Learning Style Inventory (LSI).

The Kolb model of experiential learning describes four basic modes of learning, considered to be integral parts of a continuous cycle of learning (Carrier, Newell, & Lange, 1982). These 4 modes of learning are concrete experience (CE), reflective observation (RO), formation of abstract conceptual constructs (AC), and active implementation or experimentation (AE). It is hypothesized that each individual learns best at some point along this cycle of learning phases. Learning styles are, therefore, defined as combinations of the basic modes of learning, viewed as opposites along two continuums, abstract-concrete and active-reflective. The fours styles derived are described as assimilator, accommodator, converger, and diverger (Plovnick, 1975). In this construct, the converger prefers to learn through abstract conceptualization and active experimentation. The diverger prefers the opposite, learning best through concrete experience and reflective observation. The assimilator utilizes abstract conceptualization and reflective observation, and the accommodator, contrarily prefers concrete experience and active experimentation modes of learning (Carrier, Newell, & Lange, 1982).

The Kolb LSI is a self- report instrument containing nine items each consisting of four words (Carrier, Newell, & Lange, 1982). The students are asked to rank the four words of each item in order according to how well the words characterize their styles. This instrument has been utilized to assess the learning styles at professional development programs (Armstrong & Parsa-Parisi, 2005), for athletic training students (Stradley, Buckley, Kaminski, Horodyski, Fleming, & Janelle, 2003), for other health profession students and to relate learning style to preferences for instructional activities (Carrier, Newell, & Lange, 1982).

A study of 193 athletic training students (Stradley, Buckley, Kaminski, Horodyski, Fleming, & Janelle, 2003) attempted to determine if there were differences in the learning styles of students among various regions of the country. Athletic training students, selected from programs accredited by the Commission on Accreditation of Allied Health Education Programs, were administered the Kolb LSI, as well as the Productivity Environmental Preference Survey. The Kolb Learning Styles Inventory measured student learning style preferences, whereas the Productivity Environmental Preference Survey measured environmental factors contributing to effective learning irrespective of learning style.

Since earlier studies verified preferences among health care students for concrete learning styles, Stradley et al. (2003) was expected to reveal a general preference for the accommodator or diverger styles of learning. Their findings did not support their assumption but rather, indicated that the learning styles were fairly evenly distributed among accommodators (29.3%), assimilators (29.3%), convergers (21.8%), and divergers (19.7%). Furthermore, the study revealed no geographic differences in learning styles. The Productivity Environmental Preference Survey also revealed wide disparity in preferred learning environments with only one element - a preference for late afternoon learning - scoring a statistically significant 60%. Having found no significant trend for a preference for one learning style over others among the athletic training students, Stradley et al. concluded, like the originator of Kolb Learning Styles Inventory, that the optimal teaching objective should be to provide as broad a range of teaching methods and activities as possible. This would provide students the opportunity to learn in their preferred mode, but also to experience and thus strengthen learning modes in which they are less strong.

The Kolb LSI was also utilized to assess the learning styles of 89 various health care students at a small mid-western university (Hauer, Straub, & Wolf, 2005). The results illustrated that mean scores for nursing students were highest in the areas of active experimentation (35.2) and reflective observation (31.1). Occupational therapy students preferred active experimentation (35.0) followed by abstract conceptualization (31.8). Physical therapy students preferred active experimentation (38.2) followed by abstract conceptualization (28.5). Speech language pathology students preferred active experimentation (37.9) followed by reflective observation (32.1). Physician assistant students scored highest in active experimentation (35.6) and abstract conceptualization (31.2). To determine the groups' overall learning style, concrete experimentation scores were subtracted from abstract conceptualization scores to determine the y-coordinate on Kolb's Learning Style Grid and reflective observation scores were subtracted from active experimentation scores to determine the x-coordinate. In Kolb's Learning Style Grid, the farther an individual's score falls from the intersection of the two axes, the more likely he is to strongly prefer that particular learning style and the less likely he will employ any of the other three styles. Conversely, the closer the individual's score falls to the intersection of the axes, the more difficult it is to assign a preferred learning style, as he is less likely to strongly favor one particular style but rather, will engage the full range of learning modalities..

In this study (Hauer, Straub, & Wolf, 2005), the learning style of physician assistant and occupational therapy students fell between the converger and assimilator styles, with abstract conceptualization common between the styles. Speech language pathology and nursing student scores fell between accommodator and diverger, with a preference for concrete experimentation. Physical therapy students fell between accommodator and converger styles, but with a higher tendency toward converger. The mode of learning shared by the two styles is active experimentation. Nursing students fell between diverger and assimilator with a slight preference for reflective observation. According to the authors, the problem is that these results conflict with earlier, similar studies carried out by other researchers. The authors suggest that the study was limited by the small number sample and perhaps influenced by the fact that all the respondents were enrolled at the same small Midwestern University. They also suggest that future studies should include age and gender demographic variables and that learning style measurement should be repeated over time to determine whether learning style remains stable, or fluctuates

The Kolb LSI was also utilized to trace the connection between preferred learning styles and medical career choices (Plovnick, 1975). A questionnaire that included a nine-item LSI and a variety of questions concerning career plans was sent to all freshman and senior medical students at an eastern medical school. Seventy-two (68%) freshman and 64 (64%) seniors responded but only the questionnaires of those that indicated certainty of career choice were included in the study. A random sub-sample of 27 senior students was then selected for interviews regarding their career decision-making process. The study found a correlation between learning style and the factors that influenced the career choice in areas such as family medicine, surgery, psychiatry, academic medicine, pathology, or other sub-specialties.

The correlations, noted with the Kolb Learning Style Inventory, may in fact measure the students' idealized vision of themselves, rather than their actual learning modes. It may also suggest that students self-select themselves precisely into those medical careers that most effectively utilize and reward their personal learning styles.

Armstrong and Parsa-Parisi (2005), administered the Kolb Learning Styles Inventory to 372 participants at a professional development program offered by Harvard Medical International. Thirty-seven percent of respondents were identified as convergers, i.e., those who proceed from an abstract concept to active experimentation. Twenty two percent were identified as accommodators, i.e., those who proceed from the concrete experience to active experimentation. Thus, the majority of participants, (50%) were on the left side of the transformation axis, i.e. appear to learn best through active experimentation.

Nevertheless, it is important to recognize that all knowledge is acquired in a cyclical fashion, moving from (1) the concrete experience through reflection upon the experience, followed by (2) active experimentation with the new knowledge, and (3) culminating in the synthesizing of the new knowledge into actual clinical experience (Armstrong & Parsa-Parisi, 2005). Consequently, Armstrong recommends that designers of continuing medical education programs should resist designing the program according to the preferred learning styles of the participants, but instead plan a curriculum that encourages all learners to undergo all four modes of learning.

A study at the University of Minnesota added a new dimension to the use of the LSI. The Kolb LSI was administered to 163 students and 26 faculty members in the university's dental hygiene program (Carrier, Newell, & Lange, 1982). The faculty was asked to complete the LSI twice; once with respect to their own learning styles, and then in terms of what they perceived were the learning styles of the students. Results of the surveys indicated that 84% of the students were accommodators and divergers, and that 78% of the teaching faculty fell within those same two quadrants. When the faculty completed the LSI in terms of their perception of the students, 82% again fell into those same two quadrants. The results indicate that congruency exists between students' and faculty's styles and that faculty are aware of the needs of their students. What remains in question though, is whether this congruency impacts academic performance.

A variation on Kolb's Learning Style Inventory, the Learning Style Inventory-Semantic Differential, was used to determine learning style differences of non-health care related majors (Wolfe, Bates, Manikowske, & Amundsen, 2005). The study found that significant differences materialized among the different majors. Of greater interest, with respect to this paper though, was the finding of a correlation between learning style and academic performance. The higher the individual's grade point average, the more likely he was to be a converger - a learner that applies concepts abstractly. Thus, this implies that the converger learning style has a stronger correlation with academic success.

Gregorc Style Delineator.

The Gregorc Style Delineator (GSD) is another widely used instrument designed to identify students' preferred cognitive learning styles. In 1982 Gregorc introduced the inventory based on the theories of C.G. Jung (Berlocher, William &Hendricson, 1985), with the intent of measuring the mediation or cognitive abilities of perception and ordering (O'Brien, 1991). The

GSD measures how the student first perceives, or takes in new information and secondly, how the student orders or integrates the new knowledge (Gould & Caswell, Stylistic differences between undergraduate athletic training students and educators: Gregorc Mind Styles, 2005). This is in accordance with Jung's work and his explanation of the differences in people based on their powers of perception and judgment (Berlocher & Hendricson, 1985). The Gregorc Style Delineator, in correspondence with Jung's perception and judgment, assesses learning preferences with the two dimensions referred to by Gregorc as perception and ordering. The Gregorc Style Delineator consists of a 10-column word matrix, with each column, consisting of 4 words (Duncan, 1996). The participant is asked to rank the four words in each of the columns from 4 to 1 based on how descriptive the word is of the participant's true self.

Each of Gregorc's dimensions is organized along a continuum. Gregorc's first dimension, Perception, is organized along a continuum from concrete to abstract and his second dimension, ordering, along a continuum from sequential to random. Abstractness is defined as the quality that enables one to perceive or apprehend intangible information and concreteness is the ability to perceive or apprehend tangible information (O'Brien, 1991). The sequential quality refers to linear, methodical, and logical information processing while randomness refers to nonlinear unstructured holistic information processing. This means that the individual with abstract perception relies on reason, emotion, and intuition while the one with concrete perception on the use of physical senses. Similarly, the sequential processor systematically arranges information into discrete categories of stored data and the random processor into broad categories of memory representations (O'Brien, 1991).

The two continuums are then placed in a quaternary arrangement to achieve mean composite scores based on both domains. Four learning styles are identified through this arrangement and these styles are referred to as Concrete Sequential (CS), Abstract Sequential (AS), Abstract Random (AR), and Concrete Random (CR). (See Figure 5: Gregorc's Mind Style Model: Graphing of Two Dimensions).

The GSD was administered to 200 undergraduate athletic training students and 50 program directors of athletic training programs (Gould & Caswell, 2006). The study measured the baseline style preferences of students and program directors, and correlated the learning style preferences, as defined by the GSD, to gender and education level as well as to academic role, i.e., student or program director.

The CS style was preferred by 63.4% overall. When looking at each group separately, class students preferred the CS style by 48%, upper class students by 40.8%, and program directors by 58.1%. Therefore, in this study, the preferred learning styles of students and program directors coincided, although program directors were more likely to prefer the CS learning style. Gould states that these findings comport with Gregorc's initial results in which the CS style was found to be most commonly preferred. Nevertheless, the results disagreed with Gregorc's order of preference, of CS followed by AS, AR, and CR styles. Although the Gould data affirmed Gregorc in that the CS style was most favored, the order differed. The students favored the CS style followed by AR, CR, and AS in that order. Furthermore, program directors favored the CS style, but followed by CR, AS, and AR in that order. Therefore, other than the choice of dominant CS style, students and program directors diverged considerably when secondary or intermediate dominant mind styles were considered. Gould concluded therefore, that either Gregorc's original assumptions of style preference among the general public was flawed, or perhaps flawed only when applied to specialized populations. Gould further suggested the possibility that students may self -elect those career fields that most utilize and reward their own style preferences. Most importantly, however, the results indeed differed from those of the general population, thereby emphasizing the importance of examining the learning styles for individual health professions.

The predominance of the concrete sequential learning style among other health professionals was confirmed in a four-year longitudinal study of dental students (Hendricson, Berlocher, & Herbert, 1987). The GSD was administered to the dental students yearly for the four years of their program. The CS learning style was, once again, noted to be the dominant learning style throughout the four years. Nevertheless, absent in this study was the exploration of how the students' dominant style correlated with that of the faculty. Furthermore, missing from both studies was whether any of these styles were, in turn, correlated with clinical and academic performance.

The identification of learning styles by the GSD has also been utilized with nursing students. Nursing students at two colleges in the mid-western United States participated in the study (Duncan, 1996). The GSD was administered to 55 practical nursing students at a vocational program and 48 nursing students at a baccalaureate program. The predominant learning style of the practical nursing students was CS at 42% while the predominant learning style for the baccalaureate students was AR at 54%. A chi-square test indicated that the differences between the two groups were meaningful. The expectations of the two programs for their students also differ. Practical nursing students are learning concrete hands-on procedures and the basic concepts of nursing principles. Baccalaureate nursing students are learning to provide more complex nursing care requiring specialized skills and problem solving. It would have been interesting to see if these preferences of learning styles could be correlated with critical thinking aptitudes and performance as practicing clinicians.

Although earlier studies cohere and validate that students of medicine and related health fields prefer the concrete sequential learning style, when physical therapy students were assessed, Olson (2002), revealed a significantly higher than usual number (34. 2%) with dual learning styles. Interestingly, among those demonstrating a dual learning style, the concrete sequential style still dominated. The most common combination learning style was concrete sequential/abstract sequential at 10.5%, followed closely by concrete sequential/abstract random style combination at 10.0 %. Among respondents with a single dominant learning style, the concrete sequential was dominant at 31.1 %.

The high percentage of physical therapy students demonstrating concrete sequential learning style, even in combination with abstract sequential or abstract random styles, may run counter to current trends in physical therapy education. The concrete sequential learner is described as being task oriented, structured, practical, predictable and thorough, with a low tolerance for ambiguity. However, the current trend in physical therapy education increasingly emphasizes theoretical frameworks and critical inquiry, an approach which would normally be considered more compatible with the analytical characteristics of abstract sequential learners, or the intuitive, investigative, problem-oriented approach associated with concrete random learners.

It is possible that the dual learning styles may actually offer some advantages to physical therapy students who increasingly will encounter an assortment of learning activities within the curricula. It is also possible that the dual learning style may be an adaptive response to the demands of the learning environment, or it may represent an evolutionary change as students' progress through their course of study (Olson & Scanlon, 2002).

The interesting additional dimension was the correlation of preferred learning styles to preferred instructional activities. Students demonstrating the concrete sequential style also showed a preference for teaching methods that are supportive, personalized, and promote a positive environment. The teaching methods least preferred by these students included guided individual study, computer assisted instruction, optional reading, and trial-and-error discovery - precisely the methods being most strongly advocated by the physical therapy professional. Again, this is somewhat inconsistent with the current trend in physical therapy education.

In regards to instructional activities, the students preferred a practical orientation. The preferred instructional activities were consistent with the predominant concrete sequential learning style expressed by the students. The least preferred instructional activities were interactive videos, workbooks, drills, and audiotapes - all commonly associated with self directed learning formats. This remains consistent with the concrete sequential learning style.

However, while the correlations between learning styles and preferred teaching methods and instructional activities were consistent with the Gregorc model, the correlations in this particular study were not particularly strong, with no correlation coefficient exceeding plus or minus .30. The learning style measure therefore accounted for no more than 9% of the variation in students' preferences in teaching methods and instructional activities. It therefore seems that knowledge of students' predominant learning style is not an extraordinarily useful predictor of student preferences in teaching methods or instructional activities.

Physician assistant students were also assessed utilizing the GSD as part of a study of 281 fulltime students at the schools of Allied Health Sciences at the University of Texas Medical Branch at Galveston (Rahr, Schmalz, Blessing, & Allen, 1991).Rahr reported on the 42 PA students that participated in the study and noted that the majority were CS learners, with a distribution of 23 CS learners, 13 AR learners, 5 AS learners, and 9 CS learners. The learning style preferences of the students of the other professions were not reported. The study also looked for differences in learning styles between the physician assistant students of the junior and senior classes and for differences in learning styles between upper and lower academic students. Utilizing a student T-test, no significant differences were found either between the junior and senior classes or between the upper and lower academic students. The learning styles of the PA students were also compared with their cumulative GPAs assessing for a predictive relationship between the type of learning style and achievement. Again, no significant correlation was noted. Although the findings are disappointing, the question remains whether the results are reflective of the assessment tools utilized to determine achievement and what defined achievement for the program. Since the assessment tools are prepared by the program faculty, consideration during their constructions may have been given to the needs of the students thereby eliminating the possibility of noting correlations. Perhaps a more objective assessment of achievement, not originating from the Program itself, may be more appropriate. For example, a more objective tool for assessing achievement of PA students may be a validated instrument for measuring critical thinking aptitudes.

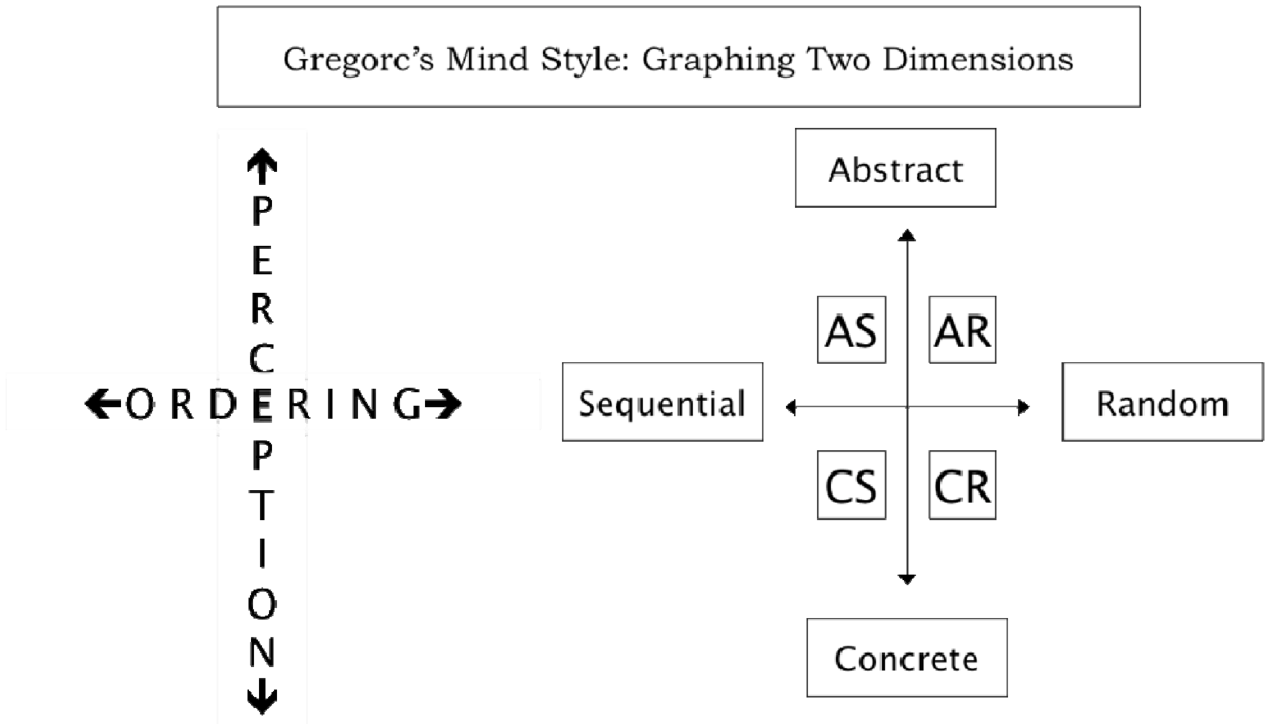

FIGURE 5. Gregorc's Mind Style: Graphing of Two Dimensions

Learning Outcomes

Learning outcomes have been attributed to various factors such as instructors' teaching methods, the congruence between teaching methods and desired outcomes and differences in the learning process or learning experiences. The effect of teaching methods was assessed utilizing a nursing module specific to the care and treatment of diabetes presented to two demographically homogenous groups (Beers, 2005). Both groups were pre- and post-tested for basic factual knowledge related to diabetes care and were then presented with the material via either the traditional lecture or the problem-based learning method.

No statistically significant difference was found in either the pre- or post-test scores of the two groups, thus supporting the null hypothesis that there is no difference in objective test scores based on teaching methods. Beers (2005) does not discount the usefulness of problem-based learning, and the development of clinical thought processes, merely suggesting that the decision of whether to use problem-based learning should be based on criteria other than test outcomes.

The study appears to eliminate teaching modalities as possible confounding factors, affecting learning outcomes. However, the study is somewhat flawed by the lack of specific data regarding the determination of learning styles and ignores the possibility of differences in critical thinking aptitudes. An unspecified majority identified themselves as both visual and auditory learners but the study unfortunately does not specify whether this determination was actually measured by some reliable learning style instrument. Given that other testing factors and reliability ratings were noted in some detail with regard to the academic testing, and not mentioned at all with regard to learning style determination, it suggests that the learning style determinations was both self-identified and quite informal. It would be interesting to know if either learning style preferences or critical thinking aptitudes, when measured more accurately, would affect the testing outcomes when comparing teaching modalities. Nevertheless it must be stressed that the lack of correlation of teaching modalities to achievement appears to eliminate a possible confounding factor.

Another study (Johnson & Mighten, 2005) also compared learning experiences to test scores, as well as pass rates. The use of lecture notes combined with structured group discussion was compared to lecture only in a 3-credit nursing medical surgical course. The results indicate that lecture followed by structured group discussion as compared to lecture alone did not result in a statistically significant higher rate of passing the course. It did, however, result in a statistically significant improvement in examination test scores, measured over 3 multiple-choice examinations. Unfortunately, neither demographic, learning style nor critical thinking data were included in this study. Therefore we cannot extrapolate the effect those factors had on the outcome data.

The matching of teaching methods to learning styles is not believed by all educators to improve learning. Joyce-Nagata (1996) studied the effects of congruency between teaching and learning styles on academic performance. The Kolb LSI was administered at two nursing schools in Mississippi to 334 nursing students as well as their respective educators. The students were divided into 4 categories based on whether students and educators matched on both dimensions, on the first dimension, the second dimension or did not match at all. When the academic performances of the four groups were compared, there were no statistically significant differences. This indicates that congruency between teaching styles and learning styles does not appear to impact on academic performance.

Immersion Learning:

There are two approaches to the learning process-that which occurs in the traditional classroom with the transmission of abstract, formally codified learning and that which occurs through active learning through an immersion experience. Immersion learning has been described as learning by doing (Lesgold A. , 2008). Immersion learning experiences provide exposure to different learning settings (Ives & Howell, 2011)and promote active participation in those experiences (Dowell, Crampton, & Parkin, 2001). These immersion experiences encourage students to use acquired knowledge to attack complex problems (Lesgold, 2001). While they encourage active learning, they have also been used to achieve other goals such as the enhancement of cultural competence (Dowell, Crampton, & Parkin, 2001).

In medical education these are the clinical experiences considered central to the medical education process (McManus, Richards, Winder, & Sprosten, 1998). They offer opportunities to train students in basic clinical skills (Remmen et. al, 2001) but are also designed to enrich the students' medical knowledge by guiding them through the medical management of patient problems (Morgan & Cleave-Hogg, 2002). These experiences allow students to observe health and disease in their natural contexts (Dowell, Crampton, & Parkin, 2001), develop their confidence (Morgan & Cleave-Hogg, 2002)as they begin to understand the relationship between the organic, psychological and social aspects of disease (Dowell, Crampton, & Parkin, 2001). Although these clinical experiences have been correlated with improvements in confidence (Morgan & Cleave-Hogg, 2002) and cultural competence (Dowell, Crampton, & Parkin, 2001) no correlations have been noted with test scores (Morgan & Cleave-Hogg, 2002) or performance on final exams (McManus, Richards, Winder, & Sprosten, 1998). In addition, the literature has not addressed the impact of these experiences on either learning styles or critical thinking aptitudes. Immersion learning, as a learning process, and its possible impact on learning style preferences and critical thinking aptitudes forms the conceptual framework for this study (See Figure 6. Conceptual Framework).

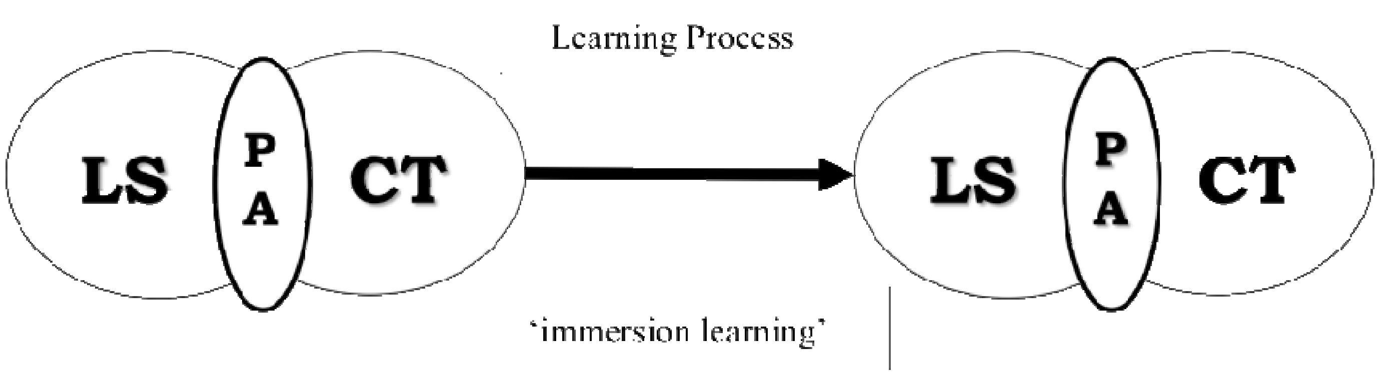

Figure 6: Conceptual Framework

Chapter III.

Methods

Design

This study was designed as a non-experimental exploratory cross-sectional analytical study (See Figure 7-Study Design). The purpose of the study was to assess the learning characteristics of PA students, specifically learning style preferences and critical thinking aptitudes, and to determine if immersion learning in the form of clinical experiences is associated with a change in either or both of those characteristics. Descriptive, comparative and correlation data were obtained to (1) identify specific learning characteristics of the population with respect to learning style preferences;(2) identify specific learning characteristics of the population with respect to critical thinking aptitudes;(3) assess for differences in learning style preferences between ‘preclinical’ and ‘clinical’ PA students; and (4) assess for differences in critical thinking aptitudes between ‘preclinical’ and ‘clinical’ PA students.

Using data derived from the sample of convenience, comparative (descriptive statistics, chi-squares and comparisons of mean) and selected analyses (t-tests and correlations) were calculated. This facilitated the identification of the group’s learning style preferences and critical thinking aptitudes and allowed for an exploration of the possible impact of immersion learning. By comparing the two subgroups (‘preclinical’ and ‘clinical’) with respect to learning style preferences and critical thinking aptitudes an investigation was initiated into the possible impact of immersion learning. The learning style preferences were determined utilizing a validated learning style inventory, the Gregorc Style Delineator, and the critical thinking aptitudes were determined using the Health Science Reasoning Test, a validated critical thinking test. A comparison of the data derived from the two subgroups (preclinical students and clinical students), utilizing both the Gregorc Style Delineator and the Health Science Reasoning Test, facilitated explorations into possible associations between immersion learning and changes in either learning style preferences or critical thinking aptitudes.

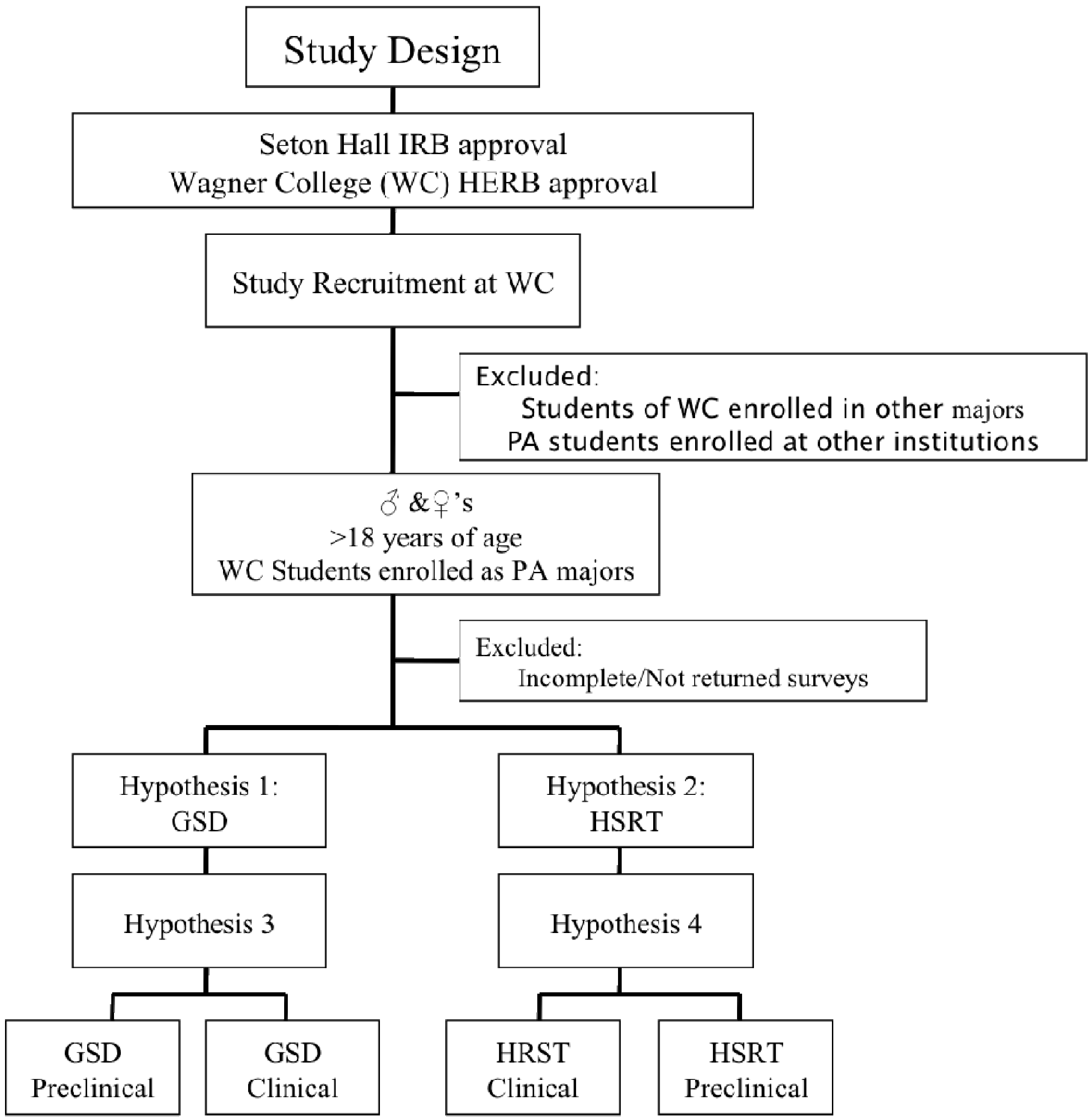

FIGURE 7 Study Design

Variables

Independent Variable.

For the purpose of this study the independent variable is 'PA Students'. For Hypothesis 1 and Hypothesis 2, all PA students included in the study were looked at as one cohort. For Hypothesis 3 and Hypothesis 4, the subjects were divided into two subgroups. Therefore, the independent variables for Hypothesis 3 and 4 were 'Preclinical PA students' and 'clinical PA students'.

Dependent Variables.

There are two dependent variables in this study:-'learning style preferences' and 'critical thinking aptitudes'. Hypotheses 1 and 3 both address the first dependent variable 'learning style preferences' while Hypotheses 2 and 4 address the second dependent variable 'critical thinking aptitudes'.

Instrumentation

The instruments utilized in this study are the Gregorc Style Delineator, used to measure learning style preferences, and the Health Science Reasoning Test, used to measure critical thinking aptitudes. These instruments were purchased with permission for student testing from Gregorc Associates and Insight Assessment respectively.

Gregorc Style Delineator.

The Gregorc Style Delineator was developed by Anthony Gregorc based on the two learning dimensions described in Gregorc's Mind Style Model and identified as perception and ordering (Duncan, 1996). The perpendicular graphing of these two dimensions (See Figure 5: Gregorc's Mind Style Model: Graphing of Two Dimensions) provides four unique learning styles, classified by the author as Concrete Sequential (CS), Abstract Sequential (AS), Abstract

Random (AR), and Concrete Random (CR). The instrument is utilized to determine individual preferences and strengths among the four learning styles and has a reliability range of 0.80-0.93 and a test-retest correlation of 0.85-0.88 (Duncan, 1996). The instrument is comprised of ten sets of four words. Based on the ordering of the four words in each of those ten sets, scores are derived for the four learning styles. These scores determine the subjects' preferred learning styles. Because the instrument distributes 100 points over four learning styles, the score for any learning style can range from a low of 10 to a high of 40. Therefore, for each of the learning styles identified as Abstract Sequential (AS), Abstract Random (AR), Concrete Sequential (CS) and Concrete Random (CR) the tester may score within a range of 10 to 40 points for a total of 100 points. This distribution of points allows the instrument to classify each of the learning styles as either 'dominant', 'intermediate', or 'low', based on the derived score. On the Gregorc Style Delineator, a score of 27 to 40 points is considered dominant; a score of 16 to 26 is intermediate while a score of 10-15 is classified as low. (See Table 1-Scoring of GSD)

TABLE 1:

Scoring of GSD

Learning Style	Dominant	Intermediate	Low
Abstract Sequential	27-40	16-26	10-15
Abstract Random	27-40	16-26	10-15
Concrete Sequential	27-40	16-26	10-15
Concrete Random	27-40	16-26	10-15

(Gregorc, 1983)

Health Science Reasoning Test.

The Health Science Reasoning Test (HSRT) was developed by Facione and Facione (2006) to assess the critical thinking aptitudes of students and practitioners of the health sciences. The HSRT is a 33-item test comprised of vignettes describing healthcare scenarios followed by multiple-choice questions. Although the vignettes focus on healthcare scenarios, no prior knowledge of healthcare is required. This instrument was developed to reflect on the thinking process skills of those preparing for as well as those practicing within a healthcare environment.

According to the HSRT Test Manual (2013),the instrumental calibrated for trainees in health science educational programs as well as for practitioners has an overall reliability coefficient of 0.81 (Facione & Facione).The instrument provides six distinct critical thinking scores. Of these scores, five are considered subscales and one is an overall score. The five subscales are identified as ‘analysis’, ‘inference’, ‘evaluation’, ‘deductive reasoning’ and ‘inductive reasoning’. The scores derived for each of the subscales are classified as either ‘strong’, ‘moderate’ or ‘weak’, while the overall score is identified as either ‘superior’, ‘strong’, ‘moderate’, or ‘weak’. (See Table 2: Scores of HSRT) This instrument, commonly used to determine critical thinking aptitudes, has also been used to measure changes in critical thinking based upon a learning intervention (D'Antoni, 2011).

The classifications of the six scores can be divided into three categories. For the subscales of analysis, inference and evaluation, a score of 5 or above is classified as ‘strong’, a score ranging between 2 and 4 is considered ‘moderate’ and a score of less than 2 is classified as ‘weak’. For the subscales of deductive and inductive reasoning, a score of 8 or above is strong, 6 to 7 is moderate and less than or equal to 5 is weak. Finally, for the overall score, greater than or equal to 25 is classified as ‘superior’, 21-25 is strong, 15-20 is moderate, and a score of less than or equal to 14 is weak. (See Table 2: Scores of HSRT)

TABLE 2.

Scoring the HSRT

	Superior	Strong	Moderate	Weak
Analysis	----	≥5	2-4	<2
Inference	----	≥5	2-4	<2
Evaluation	----	≥5	2-4	<2
Deductive	----	≥8	6-7	≤5
Inductive	----	≥8	6-7	≤5
Overall	≥26	21-25	15-20	≤14

(HSRT Test Manual, 2013)

Immersion Learning.

For the purpose of this study, immersion learning, also described as learning by doing (Lesgold A. , 2008)refers to the PA students' clinical experiences. These experiences, central to medical education (McManus, Richards, Winder, & Sprosten, 1998), enable students to observe health and disease in their natural contexts (Dowell, Crampton, & Parkin, 2001). They are designed to enrich knowledge through active participation (Morgan & Cleave-Hogg, 2002), and to prepare students for future practice. Although these experiences have been shown to improve cultural competence and to increase confidence (Morgan & Cleave-Hogg, 2002), their impact on learning traits, learning styles and critical thinking aptitudes remain unknown. Comparing preclinical students to clinical students facilitates the assessment of the impact of immersion learning on learning style preferences and critical thinking aptitudes. This comparison allows for the exploration of possible associations between a learning process, immersion learning, and learning style preferences and critical thinking aptitudes.

Setting

This study was conducted at the Wagner College Physician Assistant (PA) Program, an accredited physician assistant program, housed in a private liberal arts college, Wagner College which is located in New York City.

Sample

The subjects in the study were recruited from the matriculated student body of Wagner College. A sample of convenience was utilized and selection of subjects was based on the meeting of four inclusion criteria. For this study the inclusion criteria were: (1) males and females; (2) 18 years of age or older; (3) Wagner College students; and (4) PA majors. Excluded were (1) students of Wagner College enrolled in majors other than PA; and (2) students enrolled PAs in programs other than at Wagner College. Also excluded were those with incomplete or not returned surveys.

Procedure*:*

` Upon obtaining approval of the study both from the Wagner College Human Experimental Review Board (HERB) and the Seton Hall Institutional Review Board (IRB), subjects were recruited for the study from the student body of Wagner College (See Figure 7: Study Design). Students meeting the inclusion criteria were invited to participate during Orientation Day. The PA students were provided with unmarked manila envelopes with a letter of solicitation on the outside of the envelopes. Each unmarked envelope contained a demographic survey, developed by the primary investigator, the Gregorc Style Delineator and the Health Science Reasoning Test. The envelopes with the enclosed surveys were distributed by the research assistant. The students who volunteered to participate had 60 minutes in which to complete the survey and instruments included in the envelope. They were also provided with instructions by the research assistant to place the envelope with the completed surveys in a drop box, located at the exit to the room. Once all envelopes were collected, the data were compiled with respect to demographic data, learning style scores and critical thinking aptitudes scores.

For the first hypothesis of this study the dependent variable was learning style preference, as measured by the GSD. The mean scores for each of the four learning styles were calculated and used to classify each of the learning styles, in accordance with the ranges provided by the instrument, as dominant, intermediate or low (See Table 1-Scoring of GSD). The purpose was to determine which of the four learning styles was the dominant style in this study population and to determine if the other styles fell into either the intermediate or low categories. Descriptive statistics were utilized to reflect on the distribution of learning style preferences among the subjects. A chi-square analysis was used to determine whether the distribution was significant.

The dependent variable for the second hypothesis of this study was critical thinking aptitudes, as measured by the Health Science Reasoning Test. The HSRT provides six scores five subscale scores and an overall score. Mean scores were calculated for each of the six critical thinking aptitudes. The scores were then classified as either strong, moderate and/or weak, as per the score ranges identified by the HSRT (See Table 2-Scoring the HSRT). The purpose was to determine for this study population of PA students which of the critical thinking aptitudes were strong, moderate or weak. Descriptive statistics were utilized to determine the distribution of the critical thinking aptitudes within the population and a chi-square analysis determined if the distribution was significant.

For the third hypothesis, the study population was divided into two subgroups (preclinical and clinical students) and these subgroups were compared with respect to learning style preferences. The independent variables were 'preclinical PA students' and 'clinical PA students' and the dependent variables were learning styles. Mean scores per learning style were obtained for the preclinical as well as the clinical students and these means were compared utilizing a t-test looking for significant differences. The two groups were also compared with respect to the distribution of the learning styles and assessed for significant differences in the distributions.

For the fourth hypothesis, the two subgroups, identified as preclinical and clinical students, were compared with respect to critical thinking aptitudes. The independent variables were 'preclinical PA students' and 'clinical PA students' and the dependent variables were 'critical thinking aptitudes'. For each of the subgroups, the mean scores per critical thinking aptitude were calculated. The scores of the two groups were then compared per critical thinking aptitude looking for significant differences between the subgroups.

Chapter IV.

Results

Surveys packets were distributed to 150 individuals who met the inclusion criteria. Of the 150 packets distributed, 137 were returned with the enclosed surveys. This provided for a total study population of 137 PA students and a return rate of 91.3%. The study population was predominantly female (80.3%), with a mean age of 21, and with 73.7% enrolling to the college with high school educational background. (See Table 3-Study Demographics)

Of the 137 packets returned, 132 contained correctly completed Gregorc Style Delineators (96.4%) and 133 contained completed Health Science Reasoning Tests (97.1%). Therefore, with respect to Hypothesis 1 and Hypothesis 2, the samples analyzed were 132 and 133, respectively (See Figure 8: Study Population). For Hypothesis 3 and Hypothesis 4, the samples were divided into pre-clinical and clinical students. Of the 132 that completed the Gregorc Style Delineator, 66% (n=88) were in the preclinical subgroup and 34% (n=44) were in the clinical subgroup. Of the 133 who completed the Health Science Reasoning Test, 65% (n=88) were in the preclinical subgroup and 35% (n=46) were in the clinical subgroup (See Figure 9-Distribution of Preclinical vs. Clinical Study Population).

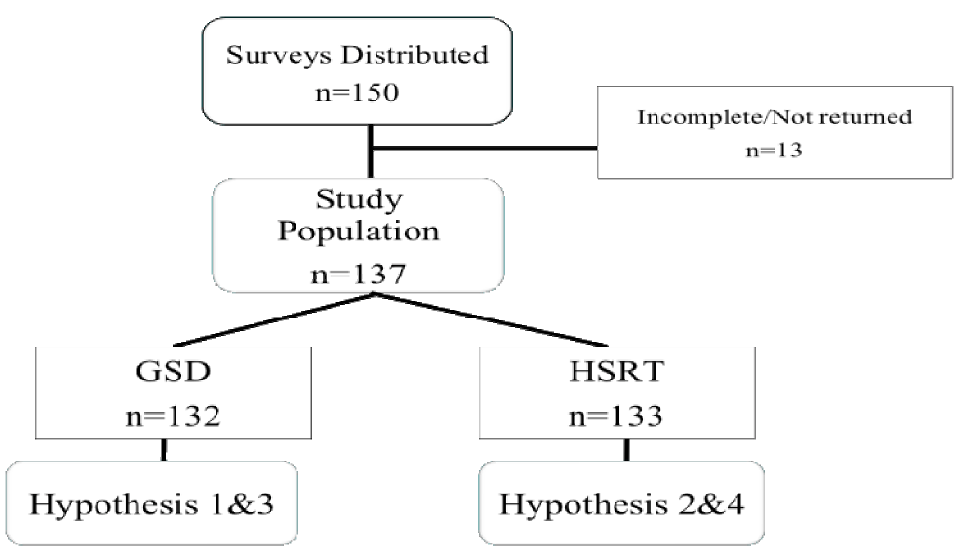

FIGURE 8. Study Population

TABLE 3.

Study Demographics

Gender		Value
Male		19.7%
Female		80.3%
Age		
Mean		21
Median		20
Range		18-45
Educational Background		
High School		73.7%
Bachelors Degree	24.8%	

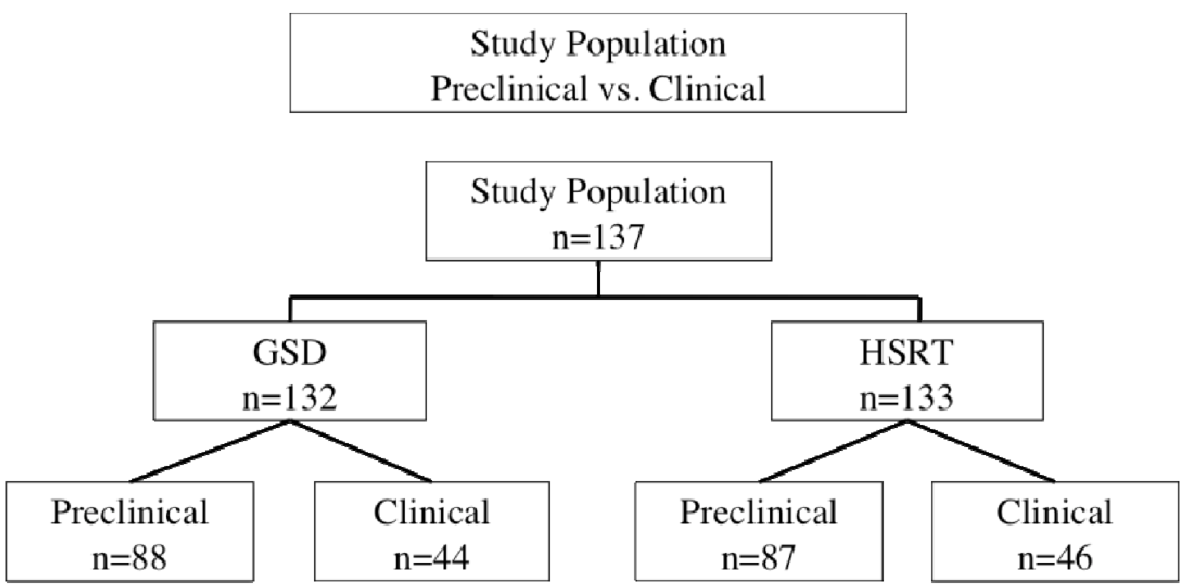

FIGURE 9. Distribution of Preclinical vs. Clinical Study Population

In response to the first research question, learning style preferences were determined utilizing the results compiled from the completed Gregorc Style Delineators. For the majority of the subjects (46.2%), the preferred learning style was Concrete Sequential. This was followed by Abstract Sequential (24.2%), Concrete Random (16.7%) and Abstract Random (12.1%) (See Table 4: Distribution of Learning Styles). On a chi-square analysis, the distribution of learning style preferences was noted to be significant, with a p value of 0.01.

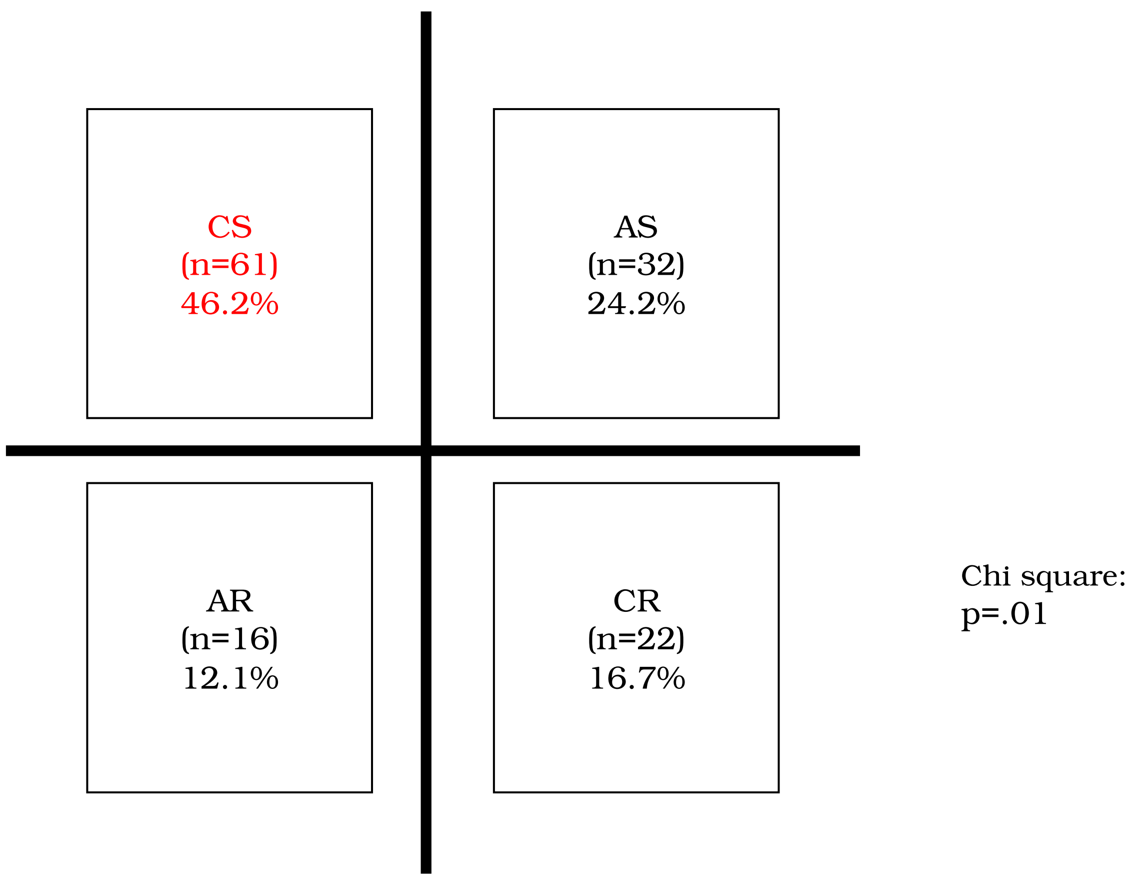

FIGURE 10. Distribution of Learning Styles

	Mean	Median	Classification
CS	27.9 ± 4.56	28	Dominant
AS	25.6 ± 4.28	26	Intermediate
AR	23.4 ± 4.48	23	Intermediate
CR	22.6 ± 4.37	22	Intermediate

TABLE 4.

Gregorc Style Delineator Scores

In addition, the learning styles were compared with respect to their mean scores and respective classifications (See Table 2: Scoring the GSD). Concrete Sequential had a median of 28 and mean of 27.9±4.56, falling into the range for 'dominant' learning styles (dominant=27-40 points). The scores for Abstract Sequential (median=26, mean=25.6±4.28), Abstract Random (median=23, mean=23.4±4.48), and Concrete Random (median=22, mean=22.6±4.37) fall in the 'intermediate' range (intermediate=16-26) points. These values indicate that for this population Concrete Sequential is a dominant learning style. These values also indicate that for this population all other styles are in the intermediate range and that there are learning styles with 'low' scores (low=10-15 points). (See Table 5-Gregorc Style Delineator Scores)

In response to the second research question, critical thinking aptitudes were assessed utilizing the HSRT. The instrument provided separate scores for six parameters identified by the instrument as analysis, inference, evaluation, deduction, induction and overall (See Table 2: Scoring of the HSRT). For each of the parameters, the median, mean and standard deviations were calculated and these scores were utilized to classify each parameter, as either 'strong' 'moderate' or 'weak'. (See Table 6: Health Science Reasoning Test Scores). In this population, two of the parameters, evaluation (median=5, mean=4.5±1.16) and overall (median=21, mean=20.5±3.97), were identified as strong. The remaining four parameters of analysis (4.0±1.23), inference (3.1±1.07), deduction (5.8±2.02) and induction (7.1±1.59) were identified as moderate. There were no parameters identified as weak. (See Table 6: Health Science Reasoning Test Scores)

TABLE 5.

Health Science Reasoning Test Scores

Parameter	Mean	Median	Classification
Analysis	4.0±1.23	4	Moderate
Inference	3.1±1.07	3	Moderate
Evaluation	4.5±1.16	5	Strong
Deductive	5.8±2.02	6	Moderate
Inductive	7.1±1.59	7	Moderate
Overall	20.5±3.97	21	Strong

In addition, the distributions of the critical thinking aptitudes were determined for the study population. While the distributions ranged from 'very strong' to 'weak', the greater proportion of the population was in the 'moderate' range. The distributions indicated that most students were moderate for analysis (47.7%), inference (64.7%) deduction (56.4%) and induction (54.1%). On the other hand most were strong for evaluation (54.9%), and overall (46.1%). These distributions were significant at p values of <.001. (See Table7: Distribution of Critical Thinking Aptitudes).

TABLE 6.

Distribution of Critical Thinking Aptitudes

	Superior	Strong	Moderate	Weak	Chi-square
Analysis	----	11.3% n=15	47.4% n=63	41.4% n=55	P<.001
Inference	----	8.3% n=9	64.7% n=86	27.1% n=36	P<.001
Evaluation	----	54.9% n=73	38.3% n=51	6.8% n=9	P<.001
Deduction	----	24.1% n=32	56.4% n=75	15.5% n=26	P<.001
Induction	----	44.4% n=59	51.1% n=68	4.5% n=6	P<.001
Overall	8% n=11	46.1% n=60	39.1% n=52	1.5% n=10	P<.001

To determine whether there was an association between immersion learning and learning style preferences, the learning style preferences of pre-clinical students were compared to those of clinical students. Subjects who completed the GSD were, therefore, divided into the two subgroups of preclinical (n=88) and clinical (n=44) students (See Figure 7-Study Population-Preclinical vs. Clinical). The two subgroups were compared with respect both to distribution of learning style preferences (See Table 8-Distribution of LS Preferences: Preclinical vs. Clinical) and mean scores per learning style (See Table 10-Comparison of LS Scores: Preclinical vs. Clinical). For both subgroups, the preferred learning style was Concrete Sequential, with a frequency of 45.3% among preclinical students and 47.8% among clinical students. In addition, the distributions, or order of frequencies, were also surprisingly similar. For both groups, Concrete Sequential (preclinical=45.3%, clinical=47.8%) was followed by Abstract Sequential (preclinical=26.7%, clinical=19.6%), Abstract Random (preclinical=16.3%, clinical =17.4%), and Concrete Random (preclinical=11.7%, clinical=15.2%). When comparing the distributions of the two groups, there was no significant difference in the distribution of learning style preferences (p=0.774). (See Table 8-Distribution of LS Preferences: Preclinical vs. Clinical).

TABLE 7.

Distribution of LS Preferences: Preclinical vs. Clinical

LS	**Preclinical**	**Clinical**
CS	45.3%	47.8%
AS	26.7%	19.6%
AR	16.3%	17.4%
CR	11.7%	15.2%

The two subgroups were also compared with respect to mean scores per learning style. Concrete Sequential was dominant for preclinical (mean=27.8±4.70) as well as clinical (mean=28.3±4.312) students. These mean scores were not found to be significantly different between the two groups (p=0.546). The scores for the other three learning styles (Abstract Sequential, Concrete Sequential, and Concrete Random) were in the moderate range for both preclinical and clinical students. Again, there were no statistical differences in mean scores between the groups (See Table 9: Distribution of LS Scores: Preclinical vs. Clinical).

TABLE 8.

Distribution of LS Scores: Preclinical vs. Clinical

	Preclinical		Clinical		
	Mean	Median	Mean	Median	T-test
CS	27.8±4.70	29	28.3±4.312	28	P=.546
AS	25.4±3.89	26	25.9±4.953	26	P=.574
AR	23.6±4.49	23	23.1±4.495	23	P=.574
CR	22.5±3.97	22	22.9±5.061	22.5	P=.626

In response to the fourth research question which asked whether there are differences in PA students' critical thinking aptitudes when comparing pre-clinical to clinical students, the subjects that completed the HSRT (n=133) were divided into the two subgroups of preclinical (n=87) and clinical (n=46) students (See Figure 7-Study Population-Preclinical vs. Clinical). The two subgroups were compared with respect both to distribution of critical thinking aptitudes as well as mean scores per critical thinking parameter (See Table 9-Comparison of CT Aptitudes-Preclinical vs. Clinical). For both groups, the students were strong for evaluation (preclinical=4.5±1.28, clinical=4.6±0.88) and overall (preclinical 19.9±4.15, clinical=20.3±3.61) while moderate for the four other parameters (analysis: preclinical=4.0±1.24, clinical=3.9±1.23, inference: preclinical=2.9±1.03, clinical=3.5±1.05, deduction: preclinical=5.7±2.05, clinical=6.2±1.96, induction: clinical=7.1±1.78, clinical=7.3±1.15). (See Table 10: CT Aptitudes-Preclinical vs. Clinical).

TABLE 9:

Critical Thinking Aptitudes-Preclinical vs. Clinical

	Preclinical		Clinical	
	Mean	Classification	Mean	Classification
Analysis	4.0±1.24	Moderate	3.9±1.23	Moderate
Inference	2.9±1.03	Moderate	3.5±1.05	Moderate
Evaluation	4.5±1.28	Moderate	4.6±0.88	Moderate
Deduction	5.7±2.05	Strong	6.2±1.96	Strong
Induction	7.1±1.78	Moderate	7.3±1.15	Moderate
Overall	19.9±4.15	Strong	20.5±3.61	Strong

However, when comparing 'preclinical PA students' to 'clinical PA students' for changes in critical thinking aptitudes, a significant improvement was noted with respect to one parameter, that of inference. The inference scores increased significantly at a p-value of 0.002 from a preclinical score of 2.9 ±1.03 to a clinical score of 3.5±1.05. (See Table 11: Change in CT Aptitudes).

TABLE 10:

Change in CT Aptitudes

	Preclinical	Clinical	T-test
Analysis	4.0±1.24	3.9±1.23	p=.591
Inference	2.9±1.03	3.5±1.05	p=.002
Evaluation	4.5±1.28	4.6±0.88	p=.483
Deduction	5.7±2.05	6.2±1.96	p=.200
Induction	7.1±1.78	7.3±1.15	p=.462
Overall	19.9±4.15	20.5±3.61	p=.582

Chapter V.

Discussion

This study is the first to investigate the learning styles and critical thinking aptitudes of PA students (n=137). It is also the first to explore associations between immersion learning experiences and learning style preferences and critical thinking aptitudes, by comparing preclinical to clinical students.

GSD Assessment of Learning Styles

Using the GSD to assess learning styles, the results indicated that for this population of PA students the preferred and dominant learning style was Concrete Sequential. This finding was consistent with previous results noted with students of other health professions. This preference for the CS learning style has been noted with dental students (Hendrickson, 1987), nursing students (Duncan, 1996), physical therapy students (Olson, 2002), athletic training students (Gould & Caswell, 2005) and a diverse group of students that included physician assistant students (Rahr, Schmalz, Blessing, & Allen, 1991). Given the rigorous admittance requirements of these programs as well as the growing body of knowledge to be learned throughout the curriculum (Eyal& Cohen, 2006) the preference in learning style was expected (Rahr, 1991). The fact that in this sample population learning style preference remained consistent when comparing preclinical to clinical students might lead one to infer that the academic program for PAs does not require the employment of diverse learning strategies which can be further expressed in their students' preferences. However, given that in this sample the three other learning styles were in the intermediate range with no style being classified as low suggests that despite the preference for the concrete sequential style, all styles were being utilized by the PA student both in the preclinical and clinical phases, regardless of immersion experiences. This supports previous findings of mixed learning styles with other health profession students, such as physical therapy students (Olson & Scanlon, 2002)and medical students (D'Antoni, 2011).

What remains to be determined is whether the dominance of the CS style is reflective of the individuals selected for these programs or of their adjustments to the materials to be learned (Robotham, 2007). In addition, it is important to note that the finding of a learning style preference as well as the finding of all styles being utilized has not been correlated with measurable outcomes, such as performance in clinical practice (Carrier, Newell, & Lange, 1982).Therefore, the implications of these findings require further investigation.

HSRT Assessment of Critical Thinking

The HSRT was utilized to assess critical thinking aptitudes. The mean scores derived from the subjects in this study indicated that the students were strong for evaluative and overall critical thinking, aptitudes, and moderate with respect to the four other subscales or parameters of critical thinking (analysis, inference, deduction and induction). These findings suggest that despite the group’s strength in evaluation, PA students are predominantly in the moderate range with respect to critical thinking aptitudes and are, therefore, in need of further development of their critical thinking skills. Acknowledging these findings may be the first step in improving the learning process. Helping them develop as critical thinkers can enhance their acquisition of knowledge, promote deeper learning (Johnson & Mighten, 2005)and better prepare them to function effectively as members of today’s healthcare team.

Immersion Learning, Comparison of Preclinical to Clinical Students

The comparison of preclinical to clinical students was performed to explore for possible associations between immersion in clinical experiences and learning style preferences and critical thinking aptitudes. With respect to learning styles, a comparison of the preclinical to clinical learning style scores indicated that the mean scores for all four styles for subjects in the clinical group did not differ significantly from the scores for subjects in the pre-clinical group. The dominant and most frequently preferred learning style for both groups was Concrete Sequential with no statistically significant difference between the frequency of 45.3% for the preclinical group and a for the clinical group and 47.8%. The preference was followed sequentially for both groups by Abstract Sequential (preclinical=26.7%, clinical=19.6%) Concrete Sequential (preclinical=16.3%, clinical=17.4%) and Concrete Random (preclinical=11.7%, clinical=15.2%). Immersion learning was not associated with a statistically significant difference between the groups with respect to the distribution of learning style preferences (p=0.774).

With respect to critical thinking aptitudes, when the mean scores for each of the six parameters were compared for subjects in the preclinical subgroup to subjects in the clinical subgroup a significant improvement in scores was noted for only one of the six parameters measured by the HSRT. The significant change in inference scores is not surprising since it reflects on a critical thinking aptitude indispensable for the medical management of patient problems (Morgan & Cleave-Hogg, 2002). It is required of clinicians in order to make appropriate treatment decisions (Wallmann & Hoover, 2012). Therefore, in order for students to succeed on their clinical experiences and derive the appropriate diagnoses of their patients (Paans, et al, 2010) it was incumbent upon them that they develop and improve that critical thinking skill.

Disappointingly, immersion in clinical experiences was not associated with a significant change in scores for analysis (p=0.591), evaluation (p=0.483), deduction (p=0.200), induction

($p=0.462$) or overall ($p=0.582$). This does not mean that these learning experiences did not promote other important attributes, not measured with a critical thinking inventory. The effect of immersion learning on attributes such as cultural competence and improvement in level of confidence (Morgan & Cleave-Hogg, 2002) cannot be discounted. Similarly, it is only through immersion in clinical experiences that students can fully understand the relationship between the organic, psychological and social aspects of disease (Dowell, Crampton, & Parkin, 2001).

Chapter VI.

Conclusions

The results of this study demonstrate that the majority of the subjects recruited from the PA students of the Wagner College PA Program preferentially concrete sequential learners with moderate to strong critical thinking aptitudes. The results further indicate that student immersion in clinical experiences is not associated with a change in either learning styles or overall critical thinking aptitudes. However, immersion learning is associated with a significant improvement in one specific critical thinking aptitude identified by the HSRT instrument as inference reasoning. Inference is a critical thinking skill that is important for deriving medical diagnoses and enhancing student learning to make appropriate medical decisions during clinical learning experiences.

The finding that PA students prefer the CS learning style is in concert with findings noted in previous studies of students in other health professions. However, the notable absence in this population of low scores for any of the other learning styles indicates that the participants in this study are utilizing all learning styles irrespective of preferred style. Whether this correlates to improved practice outcomes requires further exploration.

Similar to the findings with regards to preferred learning styles, the critical thinking aptitudes of the subjects in this study were comparable to those of students in other health profession programs. While the evaluative skills were strong, scores for the four other parameters, analysis, inference, deduction and induction, were moderate. Similar findings have been noted with nursing students, physical therapy students and medical dosimetry students (Greener, 2013). Therefore, with respect to the first two postulated hypotheses, the results of this study with PA students support the findings of previous studies with other health professions students.

Unique to this study was the exploration of the possible association of immersion learning to learning styles and critical thinking aptitudes. In this study, immersion learning, in the form of clinical experiences, did not result in a significant change in either learning style preferences (as measured by the GSD) or overall critical thinking aptitudes (as measured by the HSRT). It did, however, result in a significant improvement in inference skills (as measured by the HSRT). When comparing subjects in the pre-clinical subgroup to those in the clinical subgroup, there was a significant improvement in inference scores with an increase in score from 2.9 to 3.5 (p=0.002). Critical thinking is a higher order critical skill that enables clinicians to make sound decisions, essential for success in professional health care careers (Morgan & Cleave-Hogg, 2002), (Wallmann & Hoover, 2012). It appears that immersion in clinical experiences facilitates the development of a skill necessary for diagnosing and treating patients(Pan & Allison, 2010) thereby supporting the premise that clinical experiences are central to medical education (McManus, Richards, Winder, & Sprosten, 1998). Observing health and disease in their natural contexts (Dowell, Crampton, & Parkin, 2001)may not only help students develop confidence, but may also enrich their knowledge, while helping them to develop the skills critical to the medical management of patient problems (Morgan & Cleave-Hogg, 2002). It also provides students with an opportunity to learn to provide interprofessional patient-centered care, thereby improving their future in patients' health status while reducing diagnostic tests and referrals (Stewart, et al., 2000).

While immersion learning did not appear to impact the four other parameters of critical thinking, it is important not to discount its role in promoting other important attributes not measured with the Health Science Reasoning Test. Characteristics the instrument is not designed to measure but may nevertheless be important outcomes of immersion learning include: cultural competence (Morgan & Cleave-Hogg, 2002) an understanding of the relationship between the organic, psychological, and social aspects of disease (Dowell, Crampton, & Parkin, 2001),and increased confidence in dealing with patients of varying backgrounds (Morgan & Cleave-Hogg, 2002).

The question still remains as to why overall critical thinking scores did not significantly improve. One possibility is that results may be impacted by the structure of the medical curricula (Eyal & Cohen, 2006). Students stress memorization of voluminous amounts of lecture and reading material (Wallmann & Hoover, 2012) in preparation for multiple-choice tests that encourage the use of specific domain knowledge to generate inferences (Vosniadou, Ioannides, Dimitrakopoulou, & Papademetriou, 2001). These students would perhaps be better served through fewer traditional lectures and a greater emphasis on active learning experiences, such as simulated learning, that promote critical thinking (Sullivan-Mann, Perron, & Fellner, 2009).

The role and responsibilities of the PA profession may also have impacted the results. The subjects of this study are PA students, who may have preselected the profession in part due to its collaborative nature with limitations to professional autonomy. Keeping in mind that the focus in today's healthcare environment is on the provision of 'patient-centered care' and the utilization of the inter-professional practice model (D'Amour & Oandasan, 2005)the expectation is that PA students will be prepared to function as members of that team. It is therefore, incumbent upon them to develop the critical thinking skills needed for sound patient centered care. Identifying PA students' critical thinking aptitudes-both their strengths and weaknesses-can facilitate the selection of learning experiences that will best help students meet those goals.

In turn, programs will then achieve their primary goal of preparing qualified professionals. Through the integration of academic and clinical learning experiences (Harden, Crosby, Davis, Howie, & Struthers, 2000) they can promote the development of clinical thought processes (Ferretti, Krueger, Gabel, & Curry, 2007).Understanding their students' learning style preferences can enable educators to fine tune that learning process, leading to a greater acquisition of knowledge and fostering of clinical thought processes (Ferretti, Krueger, Gabel, & Curry, 2007).

Study Limitations

Several limitations of the study must be acknowledged and addressed in future studies. The first is the sample size (n=137), of which 5 subjects did not complete the Gregorc Style Delineator (n=132) and 4 did not complete the Health Science Reasoning Test (n=133). The subjects were a sample of convenience with minimal demographic variability with respect to gender, age, and educational background that may not be reflective of the overall national demographics for PA students. The subjects were obtained from one academic institution, thereby limiting confounding variables, but also limiting the ability to extrapolate the findings to PA students of other institutions. These subjects comprised an aggregate study population, and although the preclinical and clinical groups did not differ demographically, there may have been differences between the groups that were not noted but may have impacted the results. The findings could have been better assessed through a pre-test/post-test format with a longitudinal study following the same cohort of students from preclinical to clinical experiences.

Future Study Recommendations

The recommendations are that future studies increase sample size and demographic variability. This can be achieved by the inclusion of PA students from other academic institutions. An increase in sample size and demographic variability could also be achieved through the inclusion of students of other healthcare professions. This would allow for an exploration of similarities and differences in learning styles preferences and critical thinking aptitudes between students of different health professions. It would also allow for an assessment of specific immersion learning experiences and their impact on the development of critical thinking aptitudes. The efficacy of new immersion learning curriculums, such as simulation learning, could be assessed, as well as the impact of different clinical experiences in different clinical specialties. In addition, the study could be further expanded to include practicing PAs. The impact of their immersion in their own clinical practices could be explored as well. A longitudinal study could follow the overall cohort from enrollment, through to the preclinical student, the clinical student phase and upon graduation, into clinical practice.

References

Armstrong, E., & Parsa-Parisi, R. (2005). How can physicians' learning styles drive educational planning? *Academic Medicine* (80), 680-684.

Beers, G. W. (2005). The effect of teaching method on objective test scores: problem-based learning versus lecture. *Journal of Nursing* (44), 305-308.

Berlocher, W. C., & Hendricson, W. D. (1985). Faculty learning styles. *Journal of Dental Education* (49), 10.

Carrier, C. A., Newell, K. J., & Lange, A. L. (1982). Relation of learning styles to preferences for instructional activities. *Journal of Dental Education* (46), 11.

Cody, J. T., Adamson, K. A., Parker, R. L., & Brakhage, C. H. (2004). Evaluation of the relationship between student performance on the PACKRAT and PANCE examinatios. *Perspectives on Physician Assistant Education, 1* (15), 42-46.

D'Amour, D., & Oandasan, I. (2005). Interprofessionality as the field of interprofessional practice and interprofessional education: An emerging concept. *Journal of Interprofessional Care* , 8-20.

Dee, K. C., Nauman, E. A., Livesay, G. A., & Rice, J. (2002). Research reporting: learning styles of biomedical engineering students. *Annals of Biomedical Engineering* (30), 1100-1106.

Dehn, R. (2004). How important is computer testing experience in preparing students to take the PANCE? *Perspective on Physician Assistant Education* (16), 96-102.

Diaz, D. P., & Cartnal, R. B. (n.d.). *Comparing student learning styles in an online distance learning class and an equivalent on-campus class*. Retrieved 2005 йил 17-August from http://home.earthlink.net/-davidpdiaz?LTS/html-docs/grslss.htm

Duncan, G. (1996). An investigation of learning styles of practical and baccalaureate nursing students. *Journal of Nursing Education* (35), 40-42.

Eyal, L., & Cohen, R. (2006). Preperation for clinical practice: a survey of medical students' and graduates' perceptions of the effectiveness of their medical school curriculum. *Medical Teacher* , 162-170.

Felder, R. M. (1993). Reaching for the second tier: learning and teaching styles in college science education. *J. College Science Teaching* (23), 286-290.

Felder, R. M., & Spurlin, J. (2005). Applications, reliability and validity of the Index of Learning Styles. *Int. J. Engng, Ed.* (21), 103-112.

Gould, T. E., & Caswell, S. V. (2006). Preferred teaching and testing models of athletic training students and program directors and the relationship to styles. *Journal of Allied Health* (35), 43-49.

Gould, T. E., & Caswell, S. V. (2005). Stylistic differences between undergraduate athletic training students and educators: Gregorc Mind Styles. *Journal of Athletic Training* (21), 103-112.

Hardigan, P. C., & Cohen, S. R. (2003). A comparison of learning styles among seven health professions: implications for optometric education. *The Internet Journal of Allied Health Sciences and Practice* (1), 1-13.

Hauer, P., Straub, C., & Wolf, S. (2005). Learning styles of allied health students using Kolb's LSI-IIa. *Journal of Allied Health* (51), 175-181.

Hauer, P., Straub, C., & Wolf, S. (2005). Learning styles of allied health students using Kolb's LSI-IIa. *Journal of Allied Health* (34), 177-82.

Hendricson, W. D., Berlocher, W. C., & Herbert, R. J. (1987). A four year longitudinal study of dental student learning styles. *Journal of Dental Education* (51), 175-181.

Huston, J. S., & Huston, T. L. (1995). How learning style and personality type can affect performance. *The Health Care Supervisor* (13), 38-45.

Johnson, J. P., & Mighten, A. (2005). A comparison of teaching strategies: lecture notes combined with structered group discusion versus lecture only. *Journal of Nursing Education* (44), 319-322.

Keahey, D., & Goldgar, C. (2004). An intergrated evidence-based medicine curriculum in physician assistant training: from undergraduate to post graduate. *Perspective on Physician Assistant Education* (15), 91-98.

Knight, J. K., & Wood, W. B. (2005). Teaching more and lecturing less. *Cell Biology Education* (4), 298-310.

Lesgold, A. M. (2001). The Nature of Learning by Doing. Am. Psychologist, 56, 964-973. *American Psychologist, 56*, 964-973.

Lujan, H. L., & DiCarlo, S. E. (2005). First year medical students prefer multiple learning styles. *Advances in Physiological Education* (30), 13-16.

Marcy, V. (2001). Adult learning styles: how the VARK learning style inventory can be used to improve student learning. *Perspective on Physician Assistant Education* (10), 3.

Mattick, K., Dennis, I., & Bligh, J. (2004). Approaches to learning and styding in medical students: validation of a revised inventory and its relation to student characteristics and performance. *Undergraduate Medical Education* (38), 535-543.

McDonnough, J. P., & Ostserbrink, J. (2005). Learning styles: an issue in clinical education? *AANA Journal* (73), 89-93.

McManus, I. C., Richards, P., Winder, B. C., & Sprosten, K. A. (1998). Clinical experience, performance in final examinations, and learning style in medical students; prospective study. *British Medical Journal* (316), 345-350.

Morgan, P. J., & Cleave-Hogg, D. (2002). Comparison between medical students' experience, confidence and competence. *Medical Education* (36), 534-9.

Murphy, R. J., Gray, S. A., Straja, S. R., & Bogert, M. C. (2004). Student learning preferences and teaching implications. *Journal of Dental Education* , 859-866.

O'Brien, T. P. (1991). Relationships among selected characteristics of college students and cognitive style preferences. *College Student Journal* (25), 492-500.

Olson, V. G. (2000). Physical therapy student learning styles and their performances for teaching methods and instructional activities. *Doctoral Disseration, Seton Hall University* .

Olson, V. G., & Scanlon, C. L. (2002). Physical therapist students' learning styles and their teaching method and intructional activity preferences. *Journal of Physical Therapy Education* (16), 24-31.

Paul, S., Bojanczyk, M., & Lanphear, J. H. (1994). Learning preferences of medical students. *Medical Education* (28), 180-186.

Plovnick, M. S. (1975). Primary care career choices and medical student learning styles. *Journal of Medical Education* (50), 849-855.

Rahr, R. R., Schmalz, G. M., Blessing, J. D., & Allen, R. M. (1991). Learning styles and environmental preferences of PAs. *Journal of American Academy of Physician Assistants* (4), 351-355.

Robotham, D. (2007). *The application of learning style theory in higher education teaching.* Retrieved 2007 йил 26-April from http://72.14.209.104/search?q=cache:Ocke-tqgFck:www2.glos.ac.uk/GDN/discuss/kolb2.htm

Robotham, D. (2007). *The application of learning style theory in higher education teaching.* Retrieved 2007 йил 26-April from http://72.14.209.104/search?q=cache:Ocke-tqgFckJ:www2.glos.ac.uk/GDN/discuss/kolb2.htm

Scott, Q., Lloyd, L., & Kelly, C. (2005). Problem based learning in physician assistant training programs. *Perspective on Physician Assistant Education* (16), 84-88.

Sliwa, J. A., & Shade-Zeldow, Y. (1994). Physician personality types in physical medicine and rehabilitation as measured by the Myers Briggs type indicator. *American Journal of Physical Medicine and Rehabilitation* (73), 308-312.

Stradley, S. L., Buckley, B. D., Kaminski, T. W., Horodyski, M., Fleming, D., & Janelle, C. M. (2003). *Journal of Athletic Training* , S-141-S-146.

Taylor, A. D., Clark, C., & Sinclair, A. E. (1999). Personality types of family practice residents in the 1980s. *Academic Medicine* , 216-218.

Torre, D. M., Daley, B. J., Sebastian, J. L., & Elnicki, D. M. (2006). Overview of current learning theories for medical educators. *American Journal of Medicine* (119), 903-907.

Vitsupakorn, K. (2004). Learning style preferences and medical education. *Chiang Mai Med Bulletin, 1* (43), 25-31.

Wells, G. (1990). Talk about text: Where literacy is learned and taught. *Curriculum Inquiry* (4), 20.

Willingham, D. T. (2007). Can critical thinking be taught? *American Educator* , 8-19.

Wing, H. J., & Crouse, D. J. (1998). Physician assistant student opinion of electronic powerpoint assisted lectures. *Perspective on Physician Assistant Education* (9), 50-62.

Wolfe, K., Bates, D., Manikowske, L., & Amundsen, R. (2005). Learning styles: do they differ by discipline? *Journal of Family and Consumer Sciences* (97), 18-22.

Zeldow, P. B., & Daugherty, S. R. (1991). Personality profiles and specialty chocies of students from two medical school classes. *Academic Medicine* (66), 283-287.